June 1982

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WIN A SPECTRUM

sinclair user

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NEXT MONTH

- **We take the ZX Spectrum apart**
- **An assessment of the new range of Sinclair software**
- **ANOTHER GREAT COMPETITION**

LEADERS IN COMPUTER GAMES

FIRST CHOICE FOR ZX: SUPPORT:

ZX-81

ZX-80

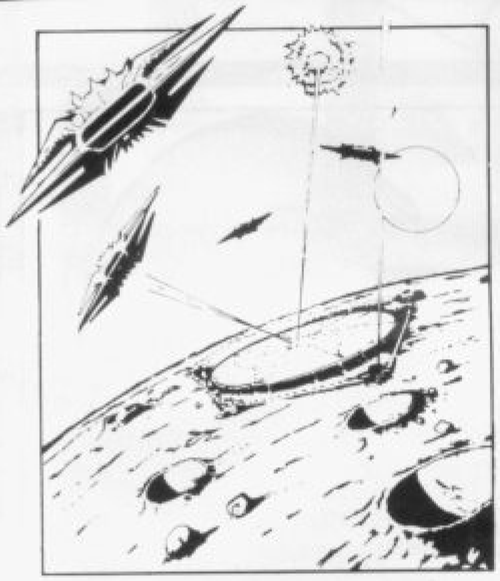


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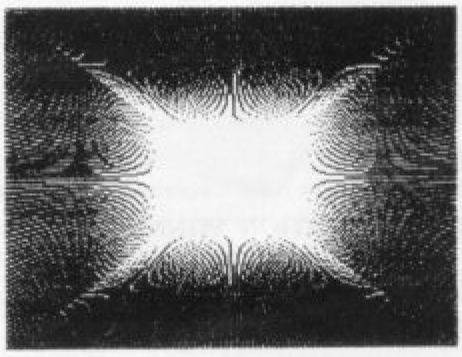
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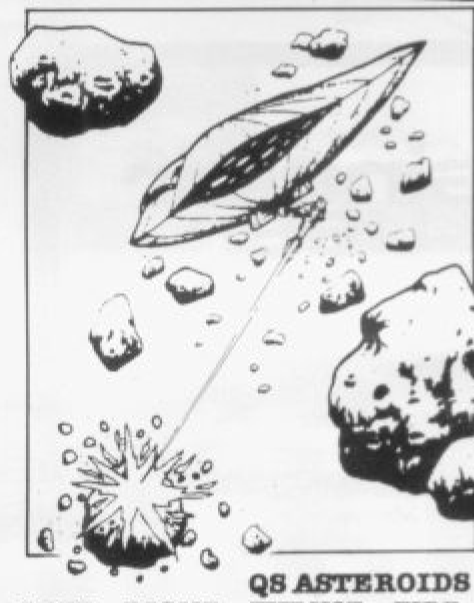
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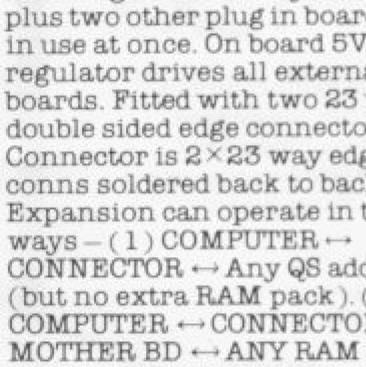
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Spectrum may hit spin-offs

THE NEXT few months could produce a massive upheaval in the companies which have been set up on the back of the amazing success of the ZX-81.

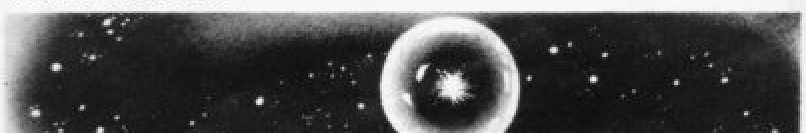
A visit to the recent ZX Microfair, the Earls Court Computer Fair, or even a quick glance through the pages of *Sinclair User* indicates the size of the industry. Better keyboards, extra memory, motherboards and much more are being produced in garages and backrooms throughout the country.

All the companies have emerged since Sinclair Research introduced the ZX-80 two years ago and provide hardware to expand the capabilities of the basic Sinclair machines. Most have found a ready market and the developments continue.

Their future, however, seems suddenly to have been undermined by the introduction of the Spectrum. With that product Sinclair seems to have covered most of the areas which the spin-off companies have been able to fill in the ZX-81 market. It has colour, sound, an easier-to-use keyboard, a much shorter loading time for programs and there are plans to introduce a microdrive with data stored on microfloppies and an interface to allow other printers to be used and to develop graphics which can be used on the U.S. and French colour television systems.

With a price of £125 for the smaller 16K RAM version, the Spectrum is also likely to put a large dent in the sales of the ZX-81. Although Sinclair has said that the Spectrum is an extension to its range of computers, it will make many people think twice before buying the ZX-81.

Even with the price of the 16K RAM pack having been reduced from £49.95 to £29.95, the cost of the 16K ZX-81 is almost £100, only £25 less than the 16K Spectrum. Add the cost of a keyboard and there is very little difference.



On that analysis, there would be little point in Sinclair continuing to produce the ZX-81. That, however, ignores one of the major attractions of the ZX-81. For a reasonable price the person with no knowledge of computers can buy one and use it to learn about simple programs and determine the capabilities of the machine.

It is likely that the demand will be maintained. The question-mark is about the way in which people will want to upgrade their systems. The most obvious move would be to continue as at present and take advantage of the existing range of peripherals but those who with to make a major leap to a system with vastly superior capabilities, and who at one time would have thought of joining the queue for the BBC Micro, will now opt for the Spectrum.

If quality can be maintained and production set at the level to meet demand, more people are likely to choose this route rather than deciding to improve their ZX-81s, leaving a growing number of unused ZX-81s. The logical step would be to sell them to help pay for the Spectrum, resulting in an increase in the ZX-81 second-hand market, enabling even more people to become ZX-81 users and introducing them to the Sinclair family of products.

With the basic ZX-81 having cost less than £70, it could be that they would be more likely to upgrade by stages rather than choose the Spectrum. How much more likely will depend on the movement of prices of all the products and their availability.

The overall conclusion must be that introduction of the ZX Spectrum will slow, but not halt, the growth of the ZX-81 hardware peripherals market and promote an increase in the second-hand market.



Scoring with bridge players

FROM the newly-formed Dunrobin Software, a bridge scorepad is claimed to be flexible and comprehensive. It is menu-driven and is said to be crash-proof, with easy-to-follow instructions.

The pad includes a scoreboard, with automatic scoring of doubles, re-doubles, honours and so on, a history page detailing each hand played, a statistics page, and the ability to save the details for later study.

The names of teams are restricted to 14 letters and if stakes are not to be played for, a 0 should be entered at the 'pence/00' prompt. To prevent the program crashing it ignores impossible inputs and awaits a valid reply. It is also possible to reject valid inputs after the bid entry routine, in case a mistake has been made.

Each cassette, which costs £4.95, contains two copies of the program and has a full list of instructions.

It was written by John Williamson and is available from Dunrobin Software at 37 Rivaldsgreen Crescent, Linlithgow, West Lothian EH49 6BB.

Toolkit routines

A CASSETTE with a series of routines is provided by JRS Software under the title Toolkit. For £3.95, eight routines can assist in the writing of programs.

All are written in machine code and take up only 164 bytes of RAM and are put in the high end of the storage to avoid being over-written by users' programs. They are for use with the 16K RAM pack and include four general routines, three graphics routines and a tape routine.

They can be used by adding the instructions as commands.

A more expensive version, at £4.95, includes other routines, plus GOTOs and GOSUBs in the line re-number.

Toolkit is available from JRS Software at 19 Wayside Avenue, Worthing, Sussex BN13 3JU.

Original graphics

MACRONICS has developed what it claims is an original technique for the production of high-resolution graphics. For £3.95 it is possible to save and re-load pictures on cassette but it cannot be listed on the ZX printer.

Large pictures can be created by dispensing with the normal character set and setting-up a system which needs following carefully to ensure that mistakes are not made.

It can be supplied in a package of four programs costing £7.95. All are available from Macronics Systems at 26 Spiers CLose, Knowle, Solihull, West Midlands B93 9ES.



IK games bargain

ELEVEN GAMES in one pack for £6 must be a bargain and as they all fit into 1K of the ZX-81 they are ideal for the person who has just bought the machine.

The games have to be simple to fit into the space but most are interesting and give a good guide to the possibilities of the ZX-81. There is a good variety with names like **Man-eating budgies, Space pirate, The wall** and **Maze.**

Attempts to play the games in sequence require stopping the cassette as soon as it has loaded but if only one game is required that can be done easily.

The pack is available from Artic Computing at 396 James Reckitt Avenue, Hull, North Humberside.

Calculation workhorse

CALCUSLAVE is described as a calculation workhorse for the ZX-81. According to its inventor, the secret of the program "lies in the superb string-handling and slicing capabilities of the ZX-81" with the data being held in strings.

It can be used for a wide range of repetitive calculations which do not need a database. The only limit is that any calculation cannot be more than 18 characters long, but within that there is a wide range of possibilities, including personal accounts, income tax, physics problems and VAT.

The program has five expressions but users can put in their own calculations. A knowledge of Basic is not needed to do that, so long as the detailed instructions are followed.

If used with a ZX printer, an automatic copy of all calculations is provided.

It takes up 14K of memory and costs £4.95. It is produced as part of a new range of software by Softouch of 16 West Leys, St Ives, Huntingdon, Cambridgeshire.

Recording holidays

A SYSTEM has been produced to provide management information on holidays and sickness for small businesses. Running on the ZX-81 with the 16K RAM pack, it will handle up to 80 records.

The holiday version compares leave entitlement to the number of days taken and will print a list of people with more than a set amount of leave not yet taken. The sick leave system records and prints the names of people with more than a set amount of time off sick.

Both systems are available on one cassette costing £9.95 from Computator, 3 Thalia Close, Greenwich, London SE10 9NA.



Disk system can add 70K

MONOLITH Electronics Ltd has produced an alternative disc system for the ZX-81. It will allow users to store up to 70K of programs or data on one disc. The discs are single-sided and at the moment only one disc drive is allowed for. The disc plugs into the back of the ZX-81 and the 16K RAM pack and printer are plugged into the disc unit.

That solves the problem of Sinclair address decoding, as the disc unit allows only the peripherals to appear in one place; the cost of the 5¼in. disc drive will be £200 and the first batch of 100 will be available this month. Monolith Electronics can be contacted at 5-7 Church Street, Crewkerne, Somerset TA 18 7HR. 0460-74321.

Noise board from Bolton

BOLTON Electronics has another board for the ZX-81 containing a music chip and audio amplifier. The chip provides three channels and a noise generator, plus a 16-bit I/O port. The tones frequency and envelopes can also be programmed. The volume of each tone can also be changed and all that is required to listen to the cacophony is a loudspeaker.

The input to the on-board amplifier is also available, if you want to use an external amplifier. The cost of the board is £21.85 and it can be obtained from Bolton Electronics, 44 Newland Drive, Bolton BL5 1DP, Lancs. Bolton 64772.

Colour from Fountain

A PROGRAMMABLE colour character generator is available from Fountain Computers Ltd, Darvill Rockley, Alresford, Hampshire, SO24 0BW. 0962-772287. The board will also provide a static screen—separate from the Sinclair one—but programmable from Basic, so that other programs of other computers which rely on a display being on while it does some fast computing can be used. The cost has not been fixed but it will be from £50-£100. The characters are compatible with Prestel and so Prestel programs could be expected to work on it without conversion.

EPROM for machine code

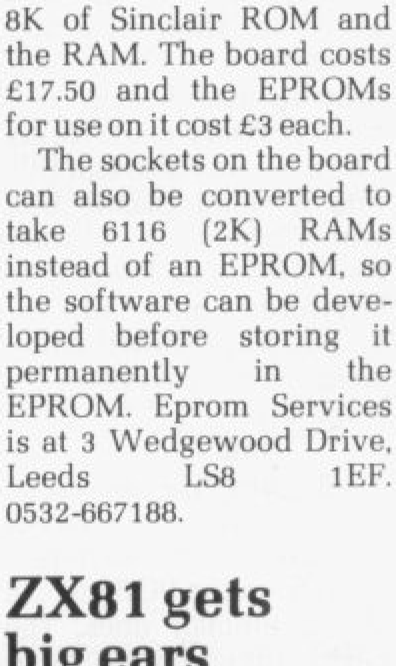
AN EPROM board which will take up to four 8K EPROMs is available from Eprom Services. Fitted to the back of the ZX-81 between the computer and the RAM pack, it can be used to store machine code routines in common use. Those routines can be written by you—for the company to put into an EPROM—or the company can supply some.

Some of the routines available are RENUMBER, FILL, SPARE MEMORY and decimal-to-hex converters. The board fits in the 8K section between the 8K of Sinclair ROM and the RAM. The board costs £17.50 and the EPROMs for use on it cost £3 each.

The sockets on the board can also be converted to take 6116 (2K) RAMs instead of an EPROM, so the software can be developed before storing it permanently in the EPROM. Eprom Services is at 3 Wedgewood Drive, Leeds LS8 1EF. 0532-667188.

ZX81 gets big ears

THE BIG EARS speech recognition system is available for the ZX-81. The system consists of a metal box containing two frequency filters, a battery-driven condenser microphone complete with stand, and a DIN socketed cable to connect to your INPUT port.



Big Ears

The only ports recommended by the firm are Technomatics, its own synthesiser board and the Redditch port. Other ports could be used, but their address would have to be inserted in the machine code routine used to obtain the voice from the frequency filter.

The system expects to have 16K of RAM attached to it and the port must be out of that section. The program reserves 256 bytes at RAMTOP for its own use and it is mainly a Basic program. The connection to the ZX-81 port must be done by soldering it to the port, as the DIN plug fits on to the frequency filter.

The system can be used to store voice prints, which are used to control the actions of the program. So shouting LEFT-a-bit, DOWN-a-bit could become common. Big Ears, costing £56.35, can be obtained from William Stuart Systems, Dower House, Herongate, Brentwood, Essex. 0277-810244.

Port unit by Bytronic

BYTRONIC Associates, which already produces a number of educational demonstration models which show how a computer can control things, has produced a port unit for the ZX-81. It consists of three ports on the one board, giving a total of 24 data lines, which can be set in groups of eight to either input or output information from the ZX-81.

Each line terminates in a screw terminal, so that external devices can be connected easily, using pieces of wire. The 16K RAM pack and other

(continued on page 10)



(continued from page 9)
extensions are catered for, by duplicating the ZX-81 connections on the far side of the board.

Detailed notes and programs in both Basic and machine code are provided with the port. The addresses of the port are memory-mapped and so can be controlled for PEEK and POKE. That should suit schools, as the same firm can supply many devices which show industrial processes under the control of a computer.

The port costs £52.05 and Bytronic is at 88, Russel Bank Road, Sutton Coldfield, West Midlands B74 4RJ. 0675-81448/021-353 2796. By the way, the people who run the company are teachers.

Cheapest RAM pack?

THE CHEAPEST 16K RAM pack for the Sinclair must be the one advertised by AVC Software at £32.50. It contains 16K of 4116 dynamic RAM chips and all the proper decoding for the RAM. It is the same as is being sold by several other companies, but this is the cheapest. It is only half the size of the Sinclair RAM pack but it is likely to be more reliable, as it has a tighter edge connector and no transformer to give that horrible buzz. The unit is guaranteed for six months.

AVC Software can be contacted at PO Box 415, Birmingham B17 0HD and please mention the Educational ZX Users' Club, as the co-ordinator has been promoting it because he receives £1 per mention.

Push button keyboard

A KEYBOARD is now available from Redditch Electronics, which will provide push-button keys in kit or ready-made forms. The company also can fit it into a small plastic box, which is big enough to take the ZX-81 PCB. The correct keywords and all the graphics are shown under clear plastic covers on the 3/4in. keys.

The connections to the ZX-81 are via a ribbon cable and two plugs which fit into the keyboard sockets on the PCB instead of the Sinclair ones. The keyboard is simple to fit and Redditch gives clear drawings on every stage of fitting it to the ZX-81. The keyboard costs £20.50 for the kit and £25.75 for the made-up keyboard. The case costs £10.30; all prices include VAT. Redditch Electronics, 21 Ferney Hill Avenue, Redditch, Worcestershire B97 4RU. 0527-61240.

Universal motherboard

WATFORD Electronics wants to have computers to use the same motherboard and has produced a set of boards which it says will fit the ZX-81, UK-101, Superboard, Acorn, Pet and Tangerine. The motherboard costs £42 and there are already five 'daughter' cards available. They are sound card for up to three AY-3-8910 music ICs—one supplied; PIO card using 6520 VIA chips; PROM card for 8K of EPROMs—2716 or 2732; and a PROM programmer for +5V PROMs.

The boards vary in price from £23 for the PIO card to £29.85 for the PROM programmer. Watford Electronics is at 33/35 Cardiff Road, Watford, Herts. 0923-40588.

Extending RAM packs

TECHNOMATICS, which produces a port for the ZX-80 and ZX-81, is now producing a low-priced PCB for extending the connections from RAM packs. The board is approximately 1in. wide by 3in. long and has the same fingered edge as the ZX machines on both sides.

A slot is cut in the correct place. That means that if you have a RAM pack, like that of Sinclair, or port which does not allow you to connect other things at the back, the PCB can be soldered on to the back of the edge connector to duplicate the expansion port of the computer. The cost of the PCB is 25 pence.

Technomatics has two shops—305 Edgware Road, London, W2, 723-0233, and the main shop at 15 Burnley Road, London NW10. 452-1500/450-6597. It can also be used to connect Vero-type prototyping boards to a motherboard which uses edge connectors.

Versatile board

UNIVERSITY Computers can now provide a board which plugs into the ZX-81 and not only an analogue port but an EPROM socket and a real-time clock. The port is in two sizes, A and B options. A consists of the analogue port and the EPROM socket. Option B includes the real-time clock as well. A Veroboard experimenters' board is also available from the same company for £7.50, complete with suggested circuits. A free consultancy service is also offered to customers.

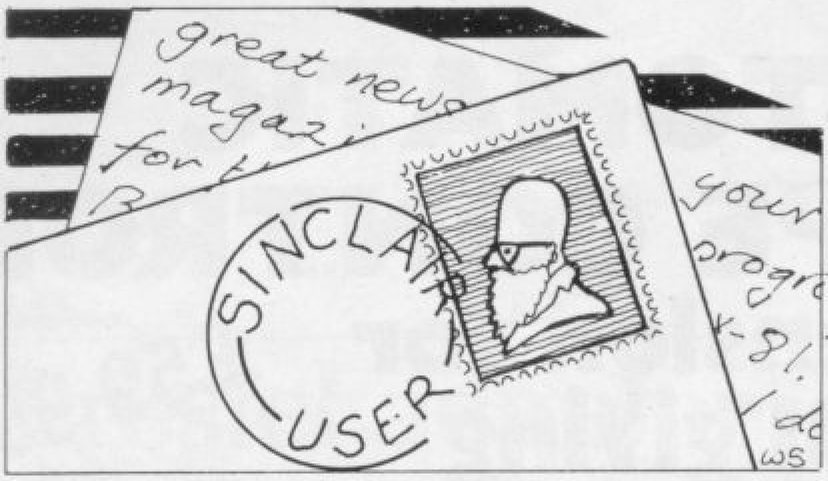
Option A costs £49.95 and Option B, including batteries, £66.20. An upgrade kit from option A to Option B is available for £30. All prices quoted are for built and tested units. University Computers, 5 St. Barnabas Road, Cambridge CB1 2BU.

Cassettes filtered

THE CF81 is a cassette filter for ZX-81s from G M Harris. It contains two filters and an amplifier in a box $2\frac{1}{2}$in. × 2in. × 1in. The way that the ZX-81 records a tone on tape can cause a 1kHz signal to be generated on top of the ZX-81 data. The low-frequency filter copes with that.

The other frequency at 12-14kHz can be caused by the fact that the tape heads oscillate at that frequency and the ZX-81 recorded frequency harmonic can clash with it, creating yet another frequency. The unit is powered from the power pack supplying the ZX-81 by plugging it into the ZX-81 ear and power sockets. The cassette leads and the power supply plug into the other side of the box.

Whether or not that happens on your tape recorder, it is certainly cheaper at £9 than buying a new tape recorder. G M Harris is at 28 Ridgeway Road, Farnham, Surrey.



Disconnect to help loading

FIRST OF ALL, it is good to have a magazine only for the Sinclair users. Unfortunately you have fallen into the same trap as other computer magazines and books.

Having looked through your **Othello** you state in your last paragraph about making changes to lines 1220 onwards to 1280. Reading the program there are no such lines.

Some of the contributors to magazines are the first to chide Uncle Clive for his shortcomings, with some of which I agree. Unfortunately they should practice what they preach when submitting programs for publication, some of which leave much to be desired, for when they have errors it is difficult for the beginner to spot them.

I would like to tell you about a tip for loading the ZX-81 which has enabled me to load 99 percent of the time. I have a 14in. black and white Waltham portable which, used in conjunction with the SUGA and using all the standard procedures, I am able to SAVE but under no circumstances can I LOAD. I discovered that the following simple method worked perfectly.

Key-in the instruction LOAD 'program name', disconnect the aerial from the back of the TV set and position it on the loop aerial or on top of the set so that it hangs at the back of the set, to give a blurred picture of the LOAD instruction. Then follow the normal loading procedure, press PLAY on the tape recorder and NEW LINE and the program LOADS, giving the 0/0 on the screen.

Replace the aerial in the back of the TV set and proceed to run the program as normal. It is not necessary to have the blurred LOAD instruction, provided that you know the exact position on the tape of the program and again making sure you do not replace the aerial before the program is fully loaded; if you do you will lose it.

It would appear that a back EMF or signal from the TV set destroys the program. I have tried the method on two other TV sets and it worked perfectly.

J Pritchard
Billericay, Essex.

- Thanks for the tip. Do readers have any other ideas they would like to pass on? We apologise for the error in the Othello but it is still possible to enjoy the game.

Black Jack points

CONGRATULATIONS on issue number one which I found most interesting. Having regard to Tim Hartnell's **Blackjack** here are two points:

I have seen it dealt under casino conditions and very often a 'shoe' is used which would contain probably packs, thus making it impossible to remember all cards which are dead.

In a normal game there are 16 chances in 52 of the next card scoring 10 but links 20 and 50 give only four such chances. If those lines are amended to read LET CA = INT (RND * 13) +12 and additional links 25 and 55 inserted to read IF CA = 11 OR CA = 12 OR CA =13 THEN LET CA = 10 the imbalance is corrected. Also the new lines 20 and 50 obviate the duplication of 1 which occurs in the program as published.

Ted Maynell
Skelton, Penrith.

Listings problems

I BOUGHT the first copy of your magazine two weeks ago and I am impressed by the general ideas and possibilities of a magazine devoted to one computer. The different dialects of Basic and different ROM mean that magazines catering for more than one computer tend to contain less specific information.

I found some rather tedious inaccuracies or bad presentation in the programs section, which is otherwise excellent value and the real "meat" of the magazine. I shall list the points for brevity:

Poor reproduction of listings in general, making the numbers sometimes difficult to read.

No listings of the variables in the programs. That makes it extremely difficult to follow a long program.

Where PRINT " " occurs, no indication is given of the numbers of blank spaces between the brackets. You can measure the distance and compare it to other characters to work out how many blanks there are but surely it would be easier to write PRINT "no. of blank spaces" or PRINT " ", since that would be much clearer. Similarly, grey squares are printed as grey squares in the listings and it is often difficult to see whether they are graphics mode press key A or H again; this could be written PRINT "graphics A" to make the listing much clearer.

Simon Cross
Ipswich.

- We accept the problems in following the program listings and will be making every effort to improve them. Do readers have any other improvements they can suggest?

Need for size of programs

I AM very pleased to see your publication. No longer will I have to purchase three or more others to find a page or two of interest from each.

I suspect, like many others with 2K, 3K or 5K—not 16K—that it would be very helpful for contributors and advertisers if they could tell us the amount of RAM used. I appreciate that many do, but many more do not.

D J Bauernfeind
Luton, Beds.

- A good point into which we are looking.



Prestel adaptor 'ready this year'



Mr Peter Carroll, left and Mr Tony Sweet of Prestel with the Martochoice prototype

PRESTEL is hoping to boost its small domestic business by the development of an adaptor for the ZX-81, which may also work with the ZX Spectrum. The adaptor would give access to all usual Prestel facilities such as databanks and the ability to do shopping at home, and also a large store of programs.

The winners of a competition to find an acceptable adaptor are now negotiating with Prestel and looking for backers to put their products into production.

The first prize of £1,000 was shared between Martochoice of Watford and Lion TV of London. The Martochoice entry altered the ZX-81 display, which has 32 characters to a line, into one with 40 characters, so that the Prestel display can be shown, The Lion entry retained the same display but allowed it to be scrolled from side to side.

Peter Carroll of the Prestel software development division said it is hoped that production of the adaptor would start before the end of the year.

The competition attracted 162 enquiries but there were only three entries. The third was from two Dutch schoolboys who were awarded a special prize of £100. Carroll said that they were so keen that they visited Britain twice to test their ideas.

New micro planned by Acorn

ACORN COMPUTERS, maker of the BBC computer, is to launch a new micro similar to the ZX Spectrum in the next few months. The Electron is expected to cost between £120 and £150 and have 32K of working memory and 32K of storage. It will be launched in a version which can be used in both Britain and the U.S.

The Spectrum costs £175 for the 48K RAM version which has 16K of working memory and can be used as yet only on British or similar colour television systems.

It is thought that the Electron will have scope for better and more flexible picture definition. The Spectrum should have more programmable functions, the ability to show a greater amount of text, and faster loading and retrieval of information.

Timex modifies ZX-81 for U.S.

TIMEX is learning from its close association with Sinclair Research and introducing its own low-cost microcomputer in the States.

Selling at $99.95, the Timex Sinclair 1000 is a 2K RAM version of the ZX-81 and is the first computer to sell for less than 100 dollars. The ZX-81 costs slightly less than 150 dollars.

Sinclair will continue to sell the ZX-81 by mail order until sales of the Timex machine reach a certain level, which is expected to happen before the end of the year. Sinclair will then concentrate on sales of its flat-screen television set.

Timex will pay Sinclair five percent royalties on all hardware sales, five percent on Sinclair-originated software and two-and-a-half percent on Timex-originated software.

The new computer will be on sale through 100,000 Timex retail outlets from July.

Sinclair Research has £10m profit

SINCLAIR Research had pre-tax profits of £10 million on turnover of £27 million in the year to the end of March. Turnover is expected to double this year.

Sales of the ZX-81 are now about 400,000, with production at 60,000 a month and expected to rise to 150,000 by the end of the year. By then output would be supplemented by the Spectrum, which would start at about 20,000 a month.

In addition there would be the sales of the new Sinclair range of software.

Last year between 60 and 70 percent of output went overseas, with the main markets being in the U.S., Germany and France.

To help fund the company's development plans, Clive Sinclair is considering reducing his 95 percent stake by a private placing of shares. Although the company has good cash reserves, the computer business is expected to grow so fast that it will need all the funds. Sinclair is also developing other products, including an electric car and a flat-screen television.

"We do not want to be in a position of choosing between computers and other projects." Sinclair says.

The size of the placing is not known but it is thought it will be about 10 percent of the company. Sinclair said he did not know how much would be raised but expected the placing to be made in September.

The merchant bank, Rothschild, is arranging the placing and has sent a firm of accountants to report on Sinclair Research finances and prospects as a basis for valuation.



Early promise is shown by colourful Spectrum

Robin Bradbeer looks at Sinclair Research's new ZX Spectrum and finds it 'incredible' value at £125

THE SPECTRUM is a colour and sound computer for the incredibly low price of £125. At that price it undercuts the BBC Microcomputer Model A, its direct competitor, by around £175. In designing the ZX-82 it is clear that the rejection of Sinclair's offer to build the BBC Micro was foremost in the company's mind. The specification is very similar and will certainly affect sales of the Acorn-based machine. It is as if Clive Sinclair has turned to the powers that be in the Government and BBC and said "I told you so".

The Spectrum is a small computer, measuring 233 × 144 × 30mm, or slightly wider but not so deep as the ZX-81. The basic model has 16KB of RAM and 16KB of ROM. That compares to most other common computers for ROM but it is more RAM than most models in the less-than £300 price range.

RAM indicates the amount of memory available to the user for working data and programs and ROM is an indication of the power of the computer to run that program and manipulate the data.



Another 32KB of memory is available at around £50 and that plugs into some sockets already built into the main board. The 48KB RAM model, therefore, is potentially as powerful as the very common Apple II computer costing around three times the price.

The main difference between the ZX-82 and the ZX-81 is immediately obvious. The keyboard has 40 keys, the same as the ZX-81. Some of the keys, notably the enter key, are slightly larger than the others. Whereas the ZX-81 had a touch-sensitive keyboard, the ZX-82 has a keyboard with keys which are about half the size of typewriter keys. They move downwards firmly and feel like the keys on desk-top calculators.

The other noticeable feature is the number of functions on the keyboard. More than 250 functions are available and some of them require three shifting operations. The colour coding of the keys and their functions makes life very easy, however, and with the single-key access to all functions, which is similar to the ZX-81, you soon become familiar with the conventions and could easily prefer them to the more normal way of doing things.

For example, to obtain the square brackets symbol involves going into extended mode, accessed by pressing the symbols shift and capitals shift keys at the same time. Then you have to press either shift and the Y key. Although that may seem rather long-winded it is still shorter than typing VERIFY, which is achieved in a similar way to the square brackets but is on the 'R' key as a single function.



Colour coding is effective in this case and the designers are to be complimented on the ergonomic strength, as well as for the design of the whole package, which feels very comfortable to hold and looks very presentable on a desk.

The Spectrum plugs into a normal UHF TV tuned to channel 36 and all characters are shown lower-case unless specified by using the capitals shift. There is a capitals lock, which is very useful. The Basic is based on that of the ZX-81 and some of the features lacking on the original model have been included in the latest one.

The screen can display 24 lines of 32 characters, although the individual pixels which make up each character—64 in all—can be accessed and changed at will. That means that 256 × 192 pixels is available for graphics.

The screen format is very similar to the Commodore. Vic, with a border area and the active screen within the border. At switch-on, the system automatically enters a mode where border and screen area, or paper as it is called, are white and the letters, or ink colour, black. That overcomes the strange effect noticeable on some colour computers where the border area is different from the working area, which makes the screen look smaller than it is.

'The 48KB RAM is potentially as powerful as the Apple II costing around three times the price'.

The colours of the border, paper and ink can be changed easily with commands of the same name. Eight colours are available, although judicious use of the graphics characters available make intermediate colours, like orange, possible. It is also possible to have 21 user-defined graphics characters, which will allow Greek or other alphabets to be used.

Unlike some computers built in the States, the Spectrum also has a £ sign on the keyboard; everything can be printed on the ZX printer, which can be used for the ZX-82 as well as the ZX-81, although the ZX-81 expansion memory pack cannot be used with the Spectrum.

Many commonly-used routines in the graphics are available automatically. For example, a circle can be drawn with the 'circle' command by specifying the centre and diameter. Lines can be drawn with the 'draw' command by specifying start and end locations.

The colour control commands are very simple to use. Brightness can be at two levels, and the character can be steady or flashing. The attributes of the character are stored as a single byte and can be accessed and changed from the Basic.

In addition to the ink and paper commands, the Basic has brightness and flashing commands. Other useful graphics functions include an over command which allows characters to be super-imposed at any point. The six colour control commands can be used over the whole active screen area or locally within each individual 8 × 8 pixel group which makes up each character.

Like the ZX-81 the plot command accesses one pixel at a time and the attributes of each block can be used to control the characteristics of that pixel. Colour control codes, which can be accessed directly from the keyboard, can be inserted into text or program listings and, when displayed, will over-ride the globally-set colours until another control code is encountered.

All control commands can also be used within strings and it is entertaining to define a string which has different-coloured characters and background colours in it. A simple print command using that string causes it to be printed to screen just as stored.

Another powerful use of colour in listing is that certain sections of the listing can be picked out in different colour—both the colour of the character and its background. It is also possible to have flashing REM statements. Any colour used in the listing is not used when running the program.

The eight colours are given numbers from 0 to 7 and they are shown clearly above the keyboard numbers. The order gives a graded grey scale on a monochrome TV display. They are black, blue, red, magenta, green, cyan, yellow and white. All eight colours may be on the screen at the same time, with some areas

(continued on page 16)





Crowds trying to see the ZX Spectrum at the Earls Court Computer Fair

(continued from page 15)

flashing, some steady, some normal brightness and some extra bright.

Editing is the same as for the ZX-81 but the addition of auto-repeat on every key makes editing easy, especially when moving the cursor around a long line.

Some additions to the Basic include the means to enter a binary number directly. That is the method of generating the user-defined characters, of which there can be 21 directly-attributable to some of the keys on the keyboard. The 8×8 matrix is made up by defining the character as a series of eight bytes, each byte being one line of the character. A 1 indicates a pixel and a 0 the absence of one. Other new functions include READ, DATA and RESTORE, something which was sorely missing on the ZX-81. FN and DEF FN are also there.

One of the best new additions to the specification is the ability to type in lower-case. That certainly makes reading and writing programs easier, especially as the keywords are still capitals. So strings, variables and arrays can be specified in a way which is simpler to use.

Unlike the ZX-81, the Spectrum uses true ASCII codes for its alpha-numeric characters and control codes. That means that ZX-81 cassettes cannot be read into the Spectrum. Other than the absence of SLOW, FAST and SCROLL, however, the Basic is identical. There is no need for FAST or SLOW, as the memory-mapped screen overcomes the need for screen writing during interlacing, as on the ZX-81. The ZX-82 has the speed of the ZX-81 in fast mode with the screen characteristics of the ZX-81 in the slow mode.

'The ZX Spectrum is a very fine computer and will give Commodore, Acorn/BBC and Atari a run for their money'.

One of the problems with both the ZX-81 and its predecessor, the ZX-80, was the rather idiosyncratic working of the cassette storage. The Spectrum incorporates a new cassette interface which is incompatible with the ZX-81. A tone leader is recorded before the information to overcome the automatic record level fluctations on some recorders.

An electronic circuit, called a Schmitt trigger, is used to remove noise on playback. All saved information is started with a header as to its type, title, length and address information. A number of types of information can be stored on cassette—programs, blocks of memory and arrays.

The MERGE function allows programs to be merged and the VERIFY function allows stored data to be checked before being erased from the computer memory, so programs and arrays may be merged from tape to combine them with the existing contents of memory; where two-line numbers or variable names coincide, the old one is erased.

Programs can also be saved with a line number to allow execution to start anywhere in the program on successful loading. By storing the screen memory, it is possible to load a screen image without having to run any program required to generate that image.

The ZX-82 has an expansion port similar to the ZX-81, with the addition of the colour video information. Thus a colour monitor could be attached to give a high-quality display. Full data, address and control buses for the Z-80 processor are available and the ZX printer can be plugged-in directly.

The LPRINT, LLIST and COPY commands work with Spectrum Basic, with the additional bonus that any user-defined graphics will also be printed. It is also possible to run a number of other peripherals at which Sinclair has only hinted. There will be an RS232C interface, so that standard printers can be attached. There will also be a network with an interface which fits on the expansion port, as will the ZX-Microdrive, to be launched later this year. It is possible to access all I/O ports by using the IN and OUT commands in the Basic.

The Spectrum has a very basic sound capability. The internal speaker emits a 'raspberry'-like sound, set normally at a frequency of middle C. The pitch and duration of the note can be defined in the Basic with the BEEP command. The centre frequency being middle C, any other note can be defined by the number of semitones above or below that frequency. It is also possible to have fractional intervals so that unusual scales can be generated.

In summary, the ZX Spectrum is a very fine computer and at the price will give Commodore, Acorn/BBC and Atari a run for their money.

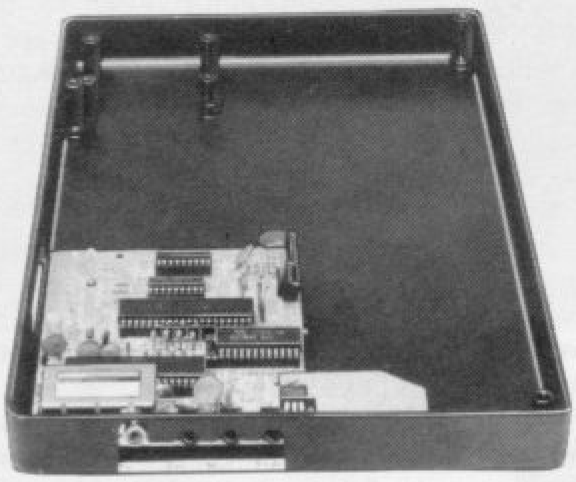
FULLER FD SYSTEM £39.95

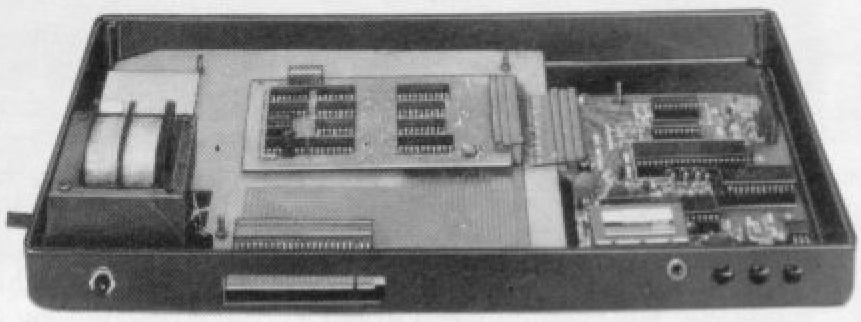
Professional Keyboard & Case for Sinclair ZX81



The ZX81 fits inside.
The tough ABS injection moulded plastic case measures 8" x 14" x 2½" and hooks up to your ZX printed circuit board in minutes. No technical know how or soldering is required.

KEYBOARD LAYOUT:
All the Sinclair ZX81 keys are duplicated on our layout, with extra shift and new line keys. The professional momentary action key switches have a guaranteed life of 10^6 operations. The unit is fully built tested and comes complete with a money back guarantee.





INSTALLATION
Simply unscrew the ZX printed circuit board from its case and screw it into the FD Case.

MOTHERBOARD:
We also manufacture a mother board which allows expansion to the ZX memory and I/0 facilities WITHIN the case, as well as our power supply unit and reset switch.

AD Code

	Price	Qty	Amount
Fuller FD System 42 Keyboard & case	39.95		
FD System Motherboard	15.95		
FD 16K. Memory Module	29.95		
FD 64K. Memory Module	78.95		
FD PSU 9 Volts at 2 amp.	12.95		
FD *Shipping and Handling*	2.50		

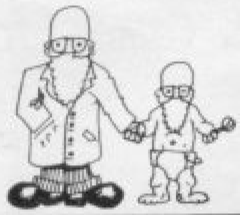
Mail to **FULLER MICRO SYSTEMS,**
The ZX Centre, Sweeting Street, Liverpool 2. England, U.K.

Name ....

Address ....

City/State/Zip ....





Nicole Segre relates how she came to terms with her son's first computer

Educating Mother

WHAT mother could forget her son's first computer program? I well remember the time Alex called me to admire his. Holding back tears of maternal pride, I sat down at the console, clumsy fingers poised tremulously over the delicate keys, while my first-born, not yet 13 years old, prepared to show me this major technological breakthrough.

"Type out your name," the little chap ordered. Poking out my tongue with the effort, I carefully touched in N-I-C-O-L-E.

"Press New Line," said Alex, and lo, the ZX-81 replied quick as a flash.

"Get lost, Nicole," it instructed.

For one who cannot even grasp a knitting pattern, never mind the infinite mysteries of an internal combustion engine, Alex's satisfaction at this trivial and even, I felt, slightly offensive result was difficult to understand.

All those hours of hard work and concentration, all that wrestling indoors with untold complexities while other children ran around breaking windows with their footballs – were they all just for that?

If Alex had delivered his simple message personally, rather than via his clever little mechanical friend, I would have boxed his ears. The Sinclair, so far as I could determine on first acquaintance, did not seem to have any ears to box but that is obviously not the point.

Ever since that innocent-looking little machine arrived in this house, one thing has become clear to me; its strange powers of fascination are in no way connected with its usefulness.

Alex once toyed with the idea of investing in a printer to enable his Sinclair to run off in batches of 100 statements such as: "I must not throw ink pellets in class." But it was decided that even a teacher would be able to spot the differences from genuine handwriting.

In the meantime, my son's ZX-81 has not achieved anything remotely practical.

Computerisation in this particular home has meant games with names like KRUNCH, BOING and GLURP. They involve various blobs chasing other blobs about the screen to eat them up or blow them up.

Then there have been games which show the scarcely-conceivable age which one's parents have reached, by demonstrating the slowness of their reflexes, and wonderful old games like noughts and crosses which in my young day there used to be some chance of winning.

There was also an interesting little program which worked out your biorhythms with the greatest of ease but this merely confirmed what I have always known – most days are the wrong days for doing most things.

On the other hand, Alex's computer does not speak your weight, switch off lights have been left on, locate lost keys, guard the chocolate biscuits or remind you to buy loo paper. Yet its arrival has caused even more of a stir in the household than did the arrival of a delightful hamster called Humphrey, not to mention the poor creature's tragic demise a year later.

Computers first made their impact on our family last year when Alex began coming home from school long after dark—pale, dazed and unable to comprehend even the simplest question. Asked what time he thought it was and where had he been, he would eventually mumble "computer club" – a far-fetched alibi if ever I heard one.

In time, however, I became convinced of the existence of such a club, although why it should possess both the attraction and the mind-bending qualities of an opium den was beyond me.

The next thing I knew, my son announced that he intended to buy one of these magical machines.

In my youth, the progression from scooter to bicycle, a mere matter of a few cogs and wheels, was the most anyone could dream of while remaining awake; and here was this little tiddler of mine about to buy a piece of the most advanced modern technology, full of silicone chips, and goodness knows what other miraculous components, all on his very own.

It was almost more than this fuddy-duddy could cope with. I was consoled by the fact that from then on, Alex could be persuaded to perform even the most menial

> Alex began coming home from school long after dark unable to comprehend even the simplest question



household chores at well below union rates, so great was his need of ready cash.

Sure enough, the day came when he set off, with close on £70 in coppers and silver slowing his every movement, to buy a computer, just as I used to go on a Saturday morning to buy a comic and a Mars bar. Things have not been the same since.

Several times a day I would answer the door bell and look out over a sea of faces. Having ascertained that the Sinclair's owner was in, the crowd would surge through the door and the stairs would groan and shudder as several tons of human—or near enough—flesh wearing mountain boots and similarly sturdy footwear charged to the top of the house.

An eerie silence would descend, to be followed several hours later by another thunder of lead soles and a chorus of cheerful goodbyes.

The children's doting grandfather found more reasons than usual for popping in at teatime. Soon venerable ancestor and his descendant would be hunched together over a keyboard, discussing various aspects of hardware from 1891 to the present and other related matters.

Old friends, from whom I was overjoyed to receive a visit after so many months, would manage only a few polite words to me before disappearing up the stairs to pick up a quick smattering of computer science and perhaps shoot down an invader or two.

Meanwhile, the computer population in the neighbourhood was growing. There was much to-ing and fro-ing as each one was admired and inspected. Shady deals were concluded on street corners, programs and other precious commodities exchanged hands, expeditions were mounted to far-flung places in search of obscure publications.

Money was extracted from innocent relatives, screens were improved, memories enlarged, and bigger and better blobs gobbled-up each other and exploded in all directions.

Where will it all end?

Before we realise, they will be assembling moon rockets in their bedrooms or devising particularly horrific weapons with which to annihilate the civilised world unless they are given more pocket money. First there was counting in units, and now this.

Right, you lot, I sometimes think, I shall get to the bottom of this, but so far the Sinclair has kept its secrets. Words like PEEK and GOTO and GOSUB and funny dollar signs hurt my head.

I shall not be put off. I am a little busy right now, but one day I shall learn to compute with the best of them, and then you can all watch out.

I wonder if a Sinclair could be programmed to answer the door bell?



In the second and final part of his series on adventure games, Phil Garrett comes to grips with Inca temples, catacombs and nasty mountains.

Fighting against assorted terrors of the imagination

ARTIC Computing advertises three **Adventures,** with the rather uninspired titles of **A**, **B** and **C**. They are written in machine code and seem to be from the same original master program, so we can probably expect more adventures in the future.

Adventure A appears to be 12½K long but on closer inspection a fair amount of this seems to be empty. It has about 20 locations, a similar number of objects, and along with the other Artic games, a large vocabulary of more than 100 words.

The setting is an alien planet which you are trying to leave, and there is a green man to deal with, a spaceship to find, and even a computer—they get everywhere. Unlike the other two games, you cannot save your present position to return later.

Adventure B is set in an Inca temple, is 11K long and is the only one of the three to give you a score. For what it is worth, mine never went above zero. This game has 50 locations with short descriptions and more than 25 objects, not including the treasures, which, as in all the Artic games, need to be used at the proper time and in the proper combination to be useful.

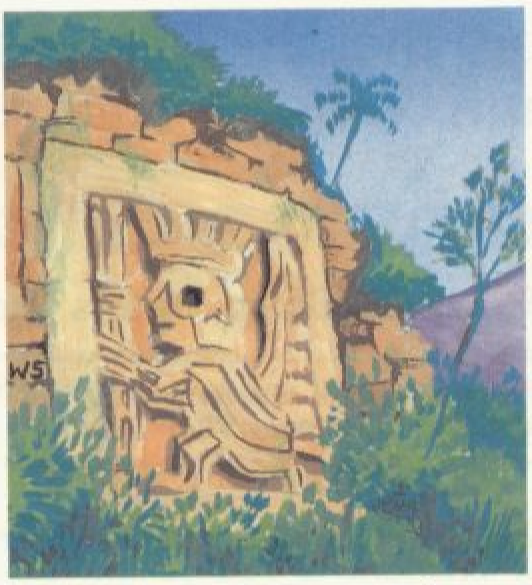
I had some problems with this game. It was sometimes very strict about the word required at a certain point; for example you cannot go "Up" the stairs, they must be "Climbed".

The 13K Adventure C is the largest of the three and is set on an alien spaceship. The object is to press a control button somewhere which will release your own ship from the fiendish Gravitron Beam and allow you to escape.

The program contains more than 35 locations and 40 objects, and is, I think, on two levels separated by a hidden door. Despite having spent hours exploring, and manipulating objects on the first level, I still have not been able to break through.

Having cheated furiously I know that, apart from the control button, the other level contains more rooms and objects, and a distinctly X-rated Android I would like to meet.

All three programs respond to "Help", although rarely helpfully,



and "R" repeats the room description.

Despite the large vocabulary, the response time is, to all intents and purposes, instantaneous, which makes a difficult and frustrating adventure easier to hear.

All the programs use the Artic keyboard scanning routine, which means that there is no response to the break key. The only way I have found to stop the programs, so that I could make a security copy, is by entering three or four "Newlines", and then a complete line of letters which overloads the display file and stops the program with a "5" error.

Having done this, I discovered that the instructions for Adventure C got the name of the program wrong. The filename is ADVENT C not ADVENT as stated.

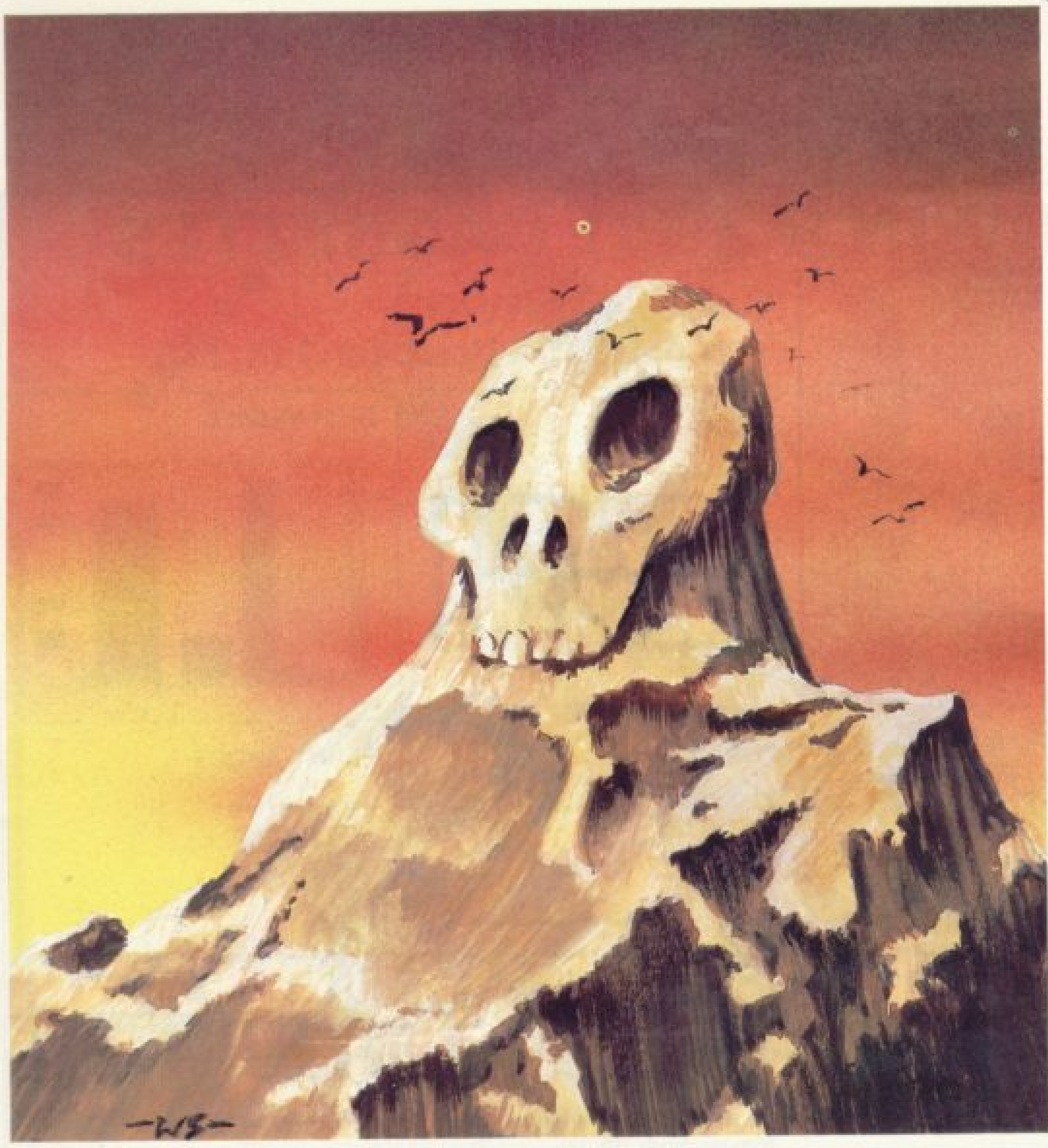
At £5, £7 and £7 for A, B and C respectively, they are all good value, and will take many, many hours to master.

Catacombs from J K Greye is an all-graphics-real time game. There is no chance of having a think about where to go next on this one, as your strength steadily drops whether or not you are doing anything.

As you move around using the standard cursor controls, the surrounding area is revealed. Each level of the catacombs is made up of a random set of inter-connected rooms containing random amounts of food, F, gold, £, and monsters, O for Ore, D for Dragon. Depending on your strength you can either fight the monsters or run away and, if necessary, you can even tunnel through the walls.

The program is written in 9½K Basic and 2K of machine code. Despite the machine code, the game takes more than two minutes to set up. Something else to watch for is the Exit, X. If you go through it you have a two-minute wait for the next level to be set up.

This is a nicely-done graphics game with your strength and score, the amount of gold you have amassed, shown on-screen. At £5.95 it is a little expensive and would be



greatly improved if the setting-up could be converted to machine code, since beginners may find the setting-up lasts longer than the game.

I have to admit that Giltrole's **Nasty Mountain** nearly had me beaten. After playing the game, studying the listing, and cheating furiously, I finally managed to get out with a score rated as "awful".

The idea is to cross a mountain via a set of seven logically-connected caves. Your tortuous path from one cave to the next is shown graphically, and the caves may contain objects, mainly edible, such as apples and carrots. The nasties are not all that fearsome, being rabbits and chickens, but they have to be treated the proper way if you want to get anywhere.

The program is written in 12K of Basic and runs at a gentle pace. Movement and picking-up objects can be done with whole words or abbreviations if preferred, but you are told your score only if .you manage to get out. You can enter 'Help" if you get stuck but all that happens is that the program determines whether or not it is still possible for you to escape, which is scarcely helpful.

This is a well-presented logical adventure, and £4.95 is a fair price.

Philip Joy's non-graphics **Cathedral Adventure** is written in 15K of Basic and describes more parts of a cathedral than I ever knew existed —more than 30 in fact. Shortish descriptions are given, sometimes including a cryptic clue—no pun intended—and more than 70 words are recognised, although the input processing routine can be slow, sometimes nearly 30 seconds.

Some of the treasures which are scattered around may be required later in the adventure, although I have not yet got past the Mad Monk to find out.

Plenty of invention has been used in working-up the locations, and some of the spelling, too, in this game, which costs £7.50.

Psion offers a tape with two sci-fi adventure-style games,. written in 9K and 14₁K of Basic. The task facing the intrepid adventurer in **Perilous Swamp** is to rescue a princess and return safely, having fought, or bribed, monsters at every turn. You are given a map to help you and a new layout is produced for each game.

The monsters, their strength, and the amount of treasure they are guarding are generated randomly at each step; you have to decide how much strength to use in overcoming them, or how much to offer as a bribe.

This program is really a fairly simple guessing game rather than an adventure; there are no objects and no special locations but it has been well done, and was a welcome relief from some of the more brain-taxing games.

The second Psion program, **Sorcerers Island** is a cross between the first and more traditional adventures. The detailed map is the same for each game and takes nearly a minute to display. There is a small vocabulary, move, fight, and so on entered as single letters, some objects, and even a rather ponderous maze. As you try to find the way off the island you use up your Life Points and hope to increase your Treasure Points.

In the process of reviewing these adventures I have been attacked by snakes and spiders, pirates and prawns, rats and rabbits, dragons and dwarfs, and countless more terrors of the imagination but it was worth it when the puzzle set by the writers of the programs was finally cracked.

What is so good about a computer is that it is limited only by our own imagination. With each new program, you can load up entire new world.

'What is so good about a computer is that it is limited only by our own imagination. With each new program you can load an entire new world'

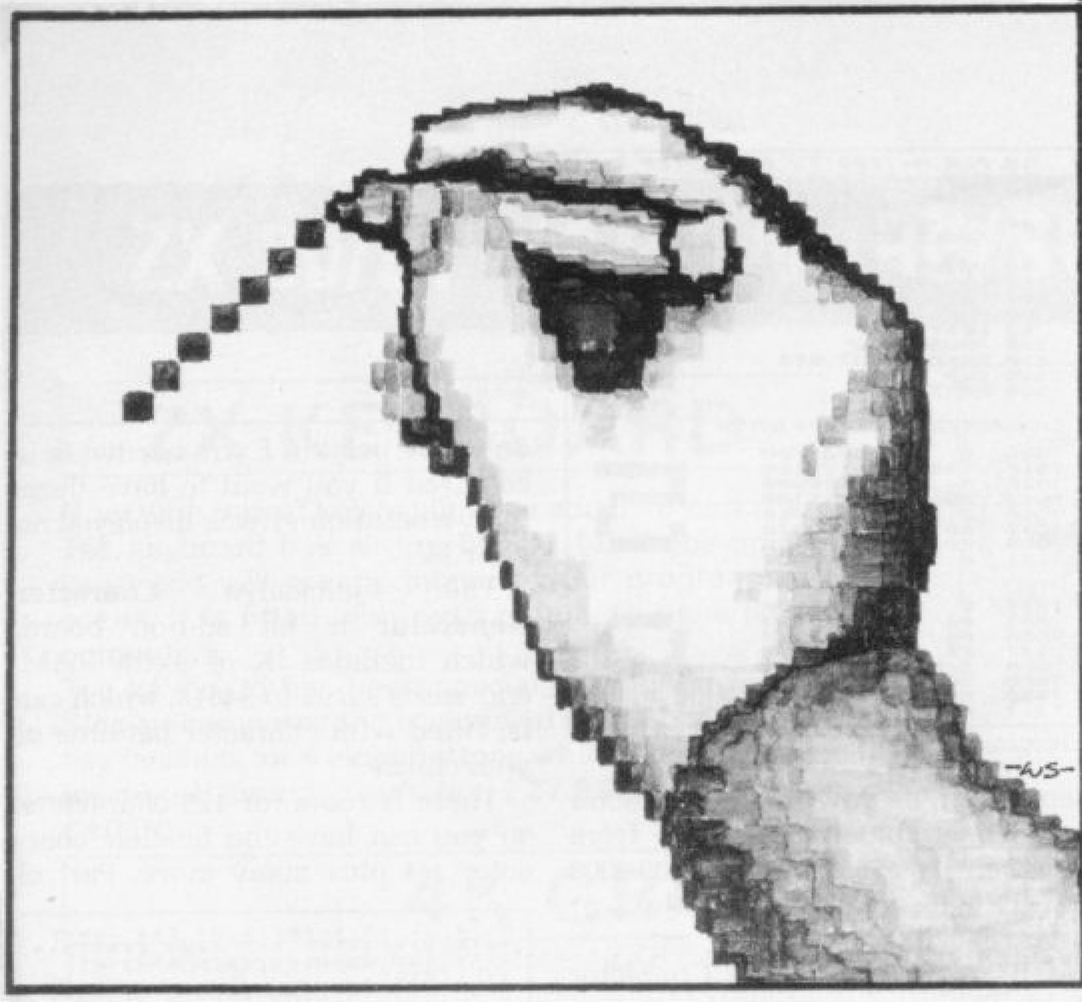
Artic Computing, 396 James Reckitt Avenue, Hull HU8 0JA.

J K Greye, 16 Park Street, Bath, Avon BA1 2TE.

Giltrole, PO Box 50, Rugby, Warwickshire CV21 4DH.

Philip Joy, 130 Rushgreen Road, Romford, Essex.

Psion Computers, 20 Clifton Court, Maida Vale, London NW8 8HT.





Making programmes more attractive

Phil Garrett looks at graphics and finds they are an ideal way of maintaining interest.

GRAPHICS on microcomputers are advertised in much the same way as soap powder. Even the smallest soap packet is Giant Size and graphics start at high resolution and go on to ultra-high resolution.

The ZX-81 has high-resolution graphics.

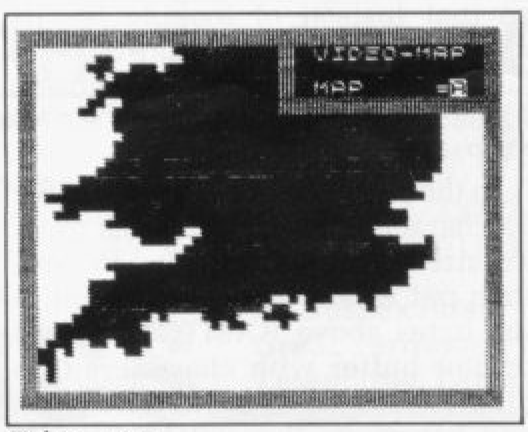
The extensive use of visual display units is a comparatively recent development. Before their spread, people were perfectly happy to use a computer with no graphics, even for games.

There are still some who regard graphics as a distraction but next time you meet a professional computer worker, ask him or her to recommend a book to explain computers to the absolute beginner. Nine times out of ten, they will recommend the "children's" Ladybird book, *The Computer*. One of the reasons is that each page of text is accompanied by a clear and relevant illustration.

In the same way computer graphics can help keep attention in an educational program, or can present information in a more easily-assimilated way using charts and graphs, or can just make any program more attractive and interesting.

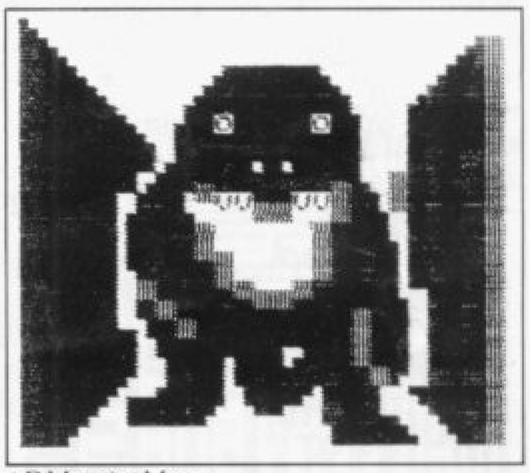
The ZX-81 high-resolution graphics have a definition of 64 pixels (picture elements) across by 44 pixels down, which is fairly low as high resolution goes. The Atom offers 256 × 192, the BBC model B 640 × 256, although a standard Apple has only 40 × 48. The problem with the higher resolution is that much larger amounts of memory are required, 20K on the BBC machine.

Worthwhile results can be obtained with Sinclair-sized pixels. Recognisable maps can be drawn as in the Video Software educational **Video Map**, passages and turnings can be shown, as in DK tronics 3D Labyrinth, and the Sinclair manual gives examples of plotting mathematical functions and straight lines, but the best on the market, with its imaginative use of the full character set, including pixels, is J K Greye's 3D Monster Maze.



Video—map

Even the instructions are livened up, with a clown doffing his hat to the player, or victim. The game, a machine code three-dimensional maze, contains the amazing monster, which, if you do not run away, gets larger and larger, lumbering towards you.


3 D Monster Maze

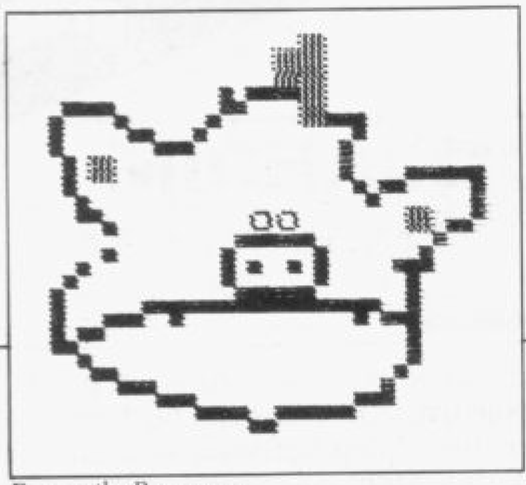
Producing good graphics is very rewarding but also extremely time-consuming. Fortunately there is some help available.

Butler, Currie and Hook's **Print 'n Plot Jotter** is an amazingly simple idea and a genuinely useful aid. The jotter is a pad of 100 A4 sheets printed with separate numbered grids for ZX-81 printing and plotting, so you can sketch-out and amend your desired graphics without either computer or temper being overheated. When the design is complete, you simply transpose it into your program.

As well as the jotter, there is also a matt polyester film available with the same grid pattern. That has the advantage of being re-usable, with care, provided a hard pencil is not used. It is also translucent, so you can trace directly over suitably-

(continued on page 26)





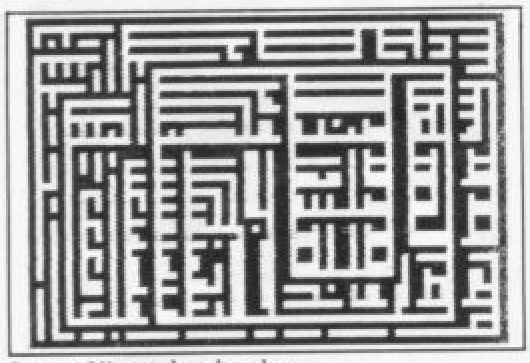
Fungus the Bogeyman

(continued from page 25)

sized photos, drawings and maps. My only minor quibble is that it would have been handy if the grids had been super-imposed as in the Sinclair manual.

It took me about 30 minutes to do the picture of Fungus the Bogeyman, which I would not have attempted without the Print 'n Plot film.

The aptly-named Picturesque **Screen Kit 1** is a completely different aid, in the form of a package of machine code subroutines contained in a single REM statement less than 1K in size. The subroutines can be called from a



Screen Kit random borders

Basic program with USR statements, and they include flicker-free scrolling up, down, left and right, clearing or reversing part of the screen, or all of it, and drawing a border round a specified area.

There is also a very handy non-graphics routine which saves and loads a program's variables at double speed and so allows the exchange of data files between programs.

It is possible to fudge the ZX-81 into giving genuine high resolution.

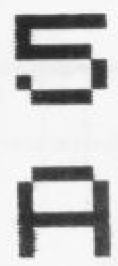
The ZX-81 is a digital computer, so not surprisingly it is all done by numbers. Every character is made up from a grid of eight-by-eight dots. A space character has all the dots off (white), and an inverse space has them all on (black).

Starting at address 7680 in the ROM, each character in turn has eight consecutive bytes which determine its pattern. Each byte represents a single row of the character and if we convert that byte from decimal, 0 to 255, to binary, 0000 0000 to 1111 1111, the pattern of dots on or off is revealed.

```
  10 FOR A=7680 TO 8192 STEP 8
  15 FOR C=0 TO 7
  20 LET D=PEEK (A+C)
  30 PRINT A+C;"    ";D
  40 FOR B=31 TO 24 STEP -1
  50 PRINT AT C,B-12;D-2*INT (D/
2)
  60 PRINT AT C,B;CHR$ ((D-2*INT
(D/2))*128)
  70 LET D=INT (D/2)
  80 NEXT B
  90 NEXT C
 100 PAUSE 100
 110 POKE 16437,255
 120 CLS
 130 NEXT A

CHARACTER TABLE PRINTER
7944    0     00000000
7945    126   01111110
7946    64    01000000
7947    124   01111100
7948    2     00000010
7949    66    01000010
7950    60    00111100
7951    0     00000000

7984    0     00000000
7985    60    00111100
7986    66    01000010
7987    66    01000010
7988    126   01111110
7989    66    01000010
7990    66    01000010
7991    0     00000000
```



Character Table Printer

I have developed the Character Table Printer program in an attempt to make all this clearer. It shows the address in the ROM, its decimal contents, the contents converted to binary, and then the binary converted into spaces and inverse spaces.

If the character set could be changed at will, then we would be talking about genuine high resolution with 256 (32 × 8) dots across by 192 (24 × 8) dots down. You cannot POKE into the ROM but there are other ways. Sinclair very kindly provides one way in the booklet supplied with its printer, which allows high resolution graphics to be output to the printer.

The LPRINT function works by reading a character from the printer buffer, address 16444 to 16476, finding the pattern of dots from the table in the ROM, and then sending that pattern to the printer.

The Sinclair fudge involves moving down RAMTOP to leave a 256-byte space, then copying the LPRINT routine from the ROM into RAM, not the area above RAMTOP. This routine is then altered slightly, so that instead of looking for its character patterns starting at address 7680, it looks from address 32255 instead, the area above RAMTOP.

In those 256 bytes there is room for 32 characters, which happens to be the size of the printer buffer. We can then put whatever dots we want in the bytes above RAMTOP, fill the printer buffer with characters 0 to 31, call our special LPRINT routine, and, hey presto, they will be dumped on to the printer. Extra hardware is required if you want to have these high-resolution effects displayed on your TV.

The Quicksilva **Character Generator** is an add-on board, which includes 1K of extra RAM, addresses 33792 to 34815, which can be fitted with character patterns of your choice.

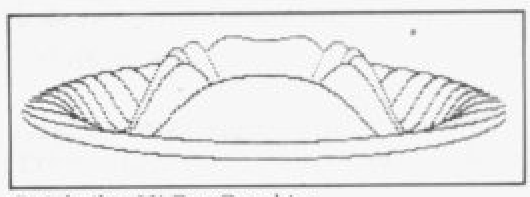
There is room for 128 characters, so you can have the Sinclair character set plus many more. Part of

```
Here is an example of the lower
case character set made possible
with the Quicksilva character
generator.
All the inverse characters have
been converted to lower case.
```

the hardware on the board spots when the ROM display routine is about to look up the pattern for a character in the ROM table and sends it to the patterns held in the extra RAM instead.

The Quicksilva **Hi-Res Graphics Board** interrupts the normal display routine in a similar way but is far more powerful and is a joy to use. The board has 6K of RAM, address 40960 to 47130, in which the high-resolution display is stored separately from the normal display file. It also has a 2K ROM, address 10240 to 12287, in the unused 8K between the Sinclair ROM and RAM.

Routines in the 2K ROM can be called from Basic or machine code to perform high-resolution plotting and line drawing in black on white or vice versa. The hi-res board is



Quicksilva Hi-Res Graphics

expensive.

Whether you use the standard character set or hi-res add-ons, fascinating and worthwhile effects are possible on the ZX-81. A pictorial alphabet for teaching early reading would be very rewarding, though it would take a good deal of effort, and a pretty snappy flight simulator should be possible with a hi-res board.

```
 5 REM "S"
10 LET N=1
15 LET M=2
20 PRINT AT M,0;"[redacted]"
25 PRINT AT 20-M,0;"[redacted]"
30 IF M=10 THEN STOP
35 LET X=INT (RND*20)
40 LET Y=INT (RND*20)
45 LET Z=INT (RND*2)
50 PRINT AT 10,0;X;"+";Y;"=";X
+Y+Z
55 PAUSE 100
60 LET A$=INKEY$
65 PRINT AT 10,0;"          "
70 IF A$="0" AND Z=0 OR A$="1"
AND Z<>0 THEN GOTO 85
75 LET M=M+1
80 GOTO 20
85 PRINT AT 1,2;N
90 LET N=N+1
95 GOTO 20
```

The winning program

The winner of our first competition finds a novel use for the ZX-81.

Learning aid comes first

JUDGING by the response to our first competition, the most popular games involve blasting various kinds of craft or aliens from the skies or travelling along tracks which are littered with a wide variety of obstacles.

In the opinion of the judges, however, the winner was a simple arithmetic game developed by John Ledger of Rushden, Northamptonshire. A teacher at a special school, he wrote the program as a teaching aid at the school.

We received an excellent response to the competition, which attracted entries from all over the country and from all age groups. Unfortunately many people failed to read the rules in detail and sent programs which needed more than the limit of 1K memory but those which met the requirements were still of such a high standard that it was difficult to determine the winner.

To reward those who were close, we have included a number in our program listing and a payment of £10 will soon be on its way.

The winning program is deceiving in its simplicity. It involves the player seeing a number of calculations and deciding whether they are correct or not by pressing either "1" if correct or "Ø" if incorrect. It the player chooses wrongly, a pair of shutters begin to close. If the player chooses the correct answer, one is added to the score.

It is a game which can be played by people of all ages, the usual scores depending on ability. Ledger said that he had difficulty reaching a score or much more than 50.

He teaches crafts at Brookfield Special School, Wellingborough but has been interested in computers for some time. He began thinking about the possibilities of using the ZX-81 as a teaching aid when he saw one of his pupils with a **Speak and Spell** game which he was given for Christmas.

"It kept his attention doing problems over and over again and I thought it was an idea which could be extended," he said.

He bought the ZX-81 at the beginning of February and since then it has become an obsession.

"There are many uses for computers in education, particularly in a school of the kind where the range of ability is so wide. Much of the teaching is very repetitive and it is easier to put it on to a computer than to have the children writing every time.

"The children seem to like using them better than having normal lessons, perhaps because they do not have someone checking them all the time. If they make a mistake, nobody except the machine sees it."

He added that despite the learning problems of the children, they had no difficulty working with the ZX-81.

With the help and advice of other members of staff, Ledger has developed a small number of programs and has plans to write a full series.

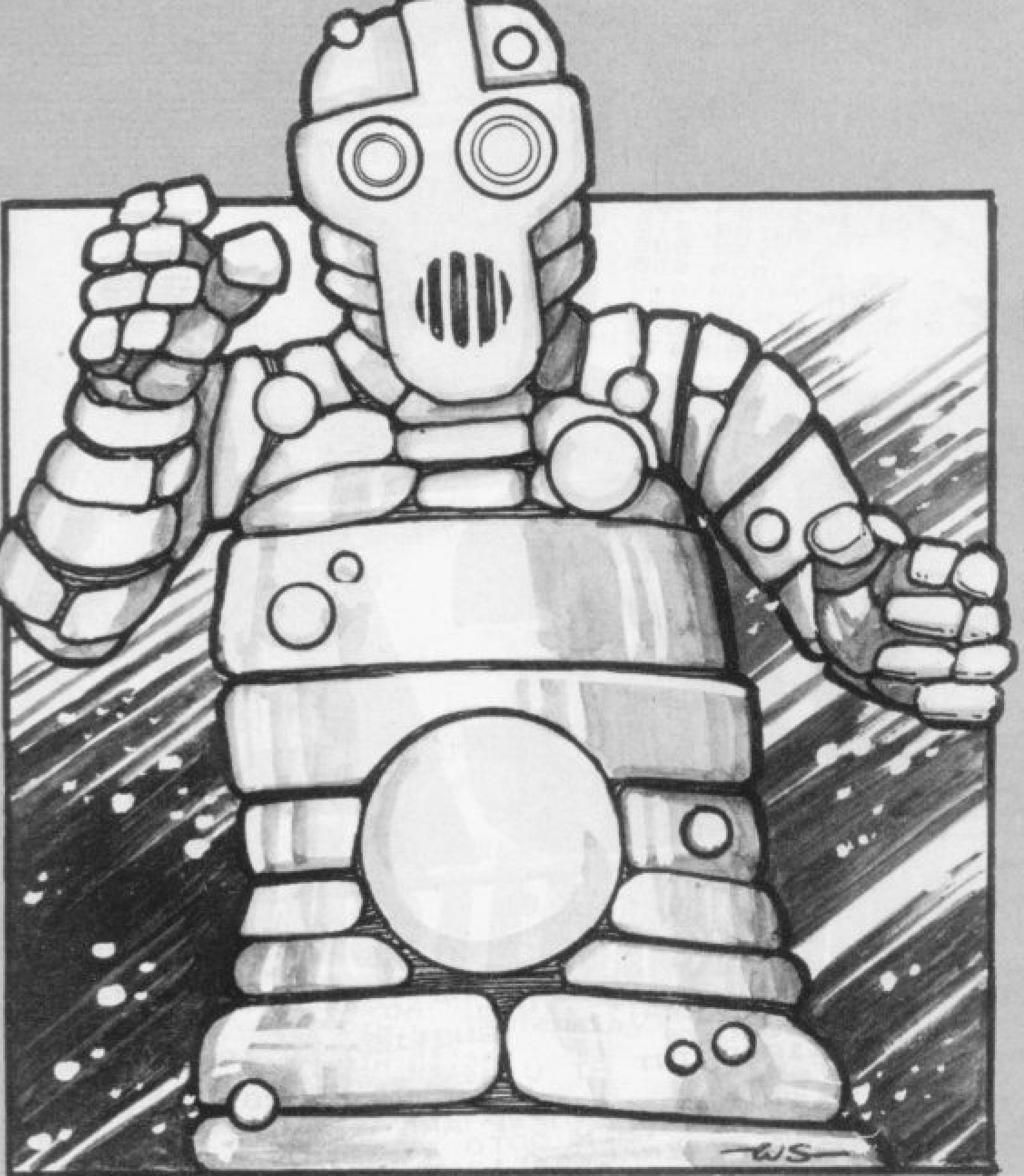
"The possibilities are endless, with programs which allow children to learn at their own speed and relieve teachers of the many repetitive tasks necessary when teaching children of this level of ability," he said.



His enthusiasm is supported by the headmaster, Joe Mulholland. He thinks the ZX-81 is a "very good starting-point for schools to learn how to use computers".

Brookfield has children between the ages of five and 16 from all over Northamptonshire. All have learning problems and need a great deal of repetitive teaching to achieve only minimal reading and mathematical ages.

PROGRAM PRINTOUT



ROBOTS

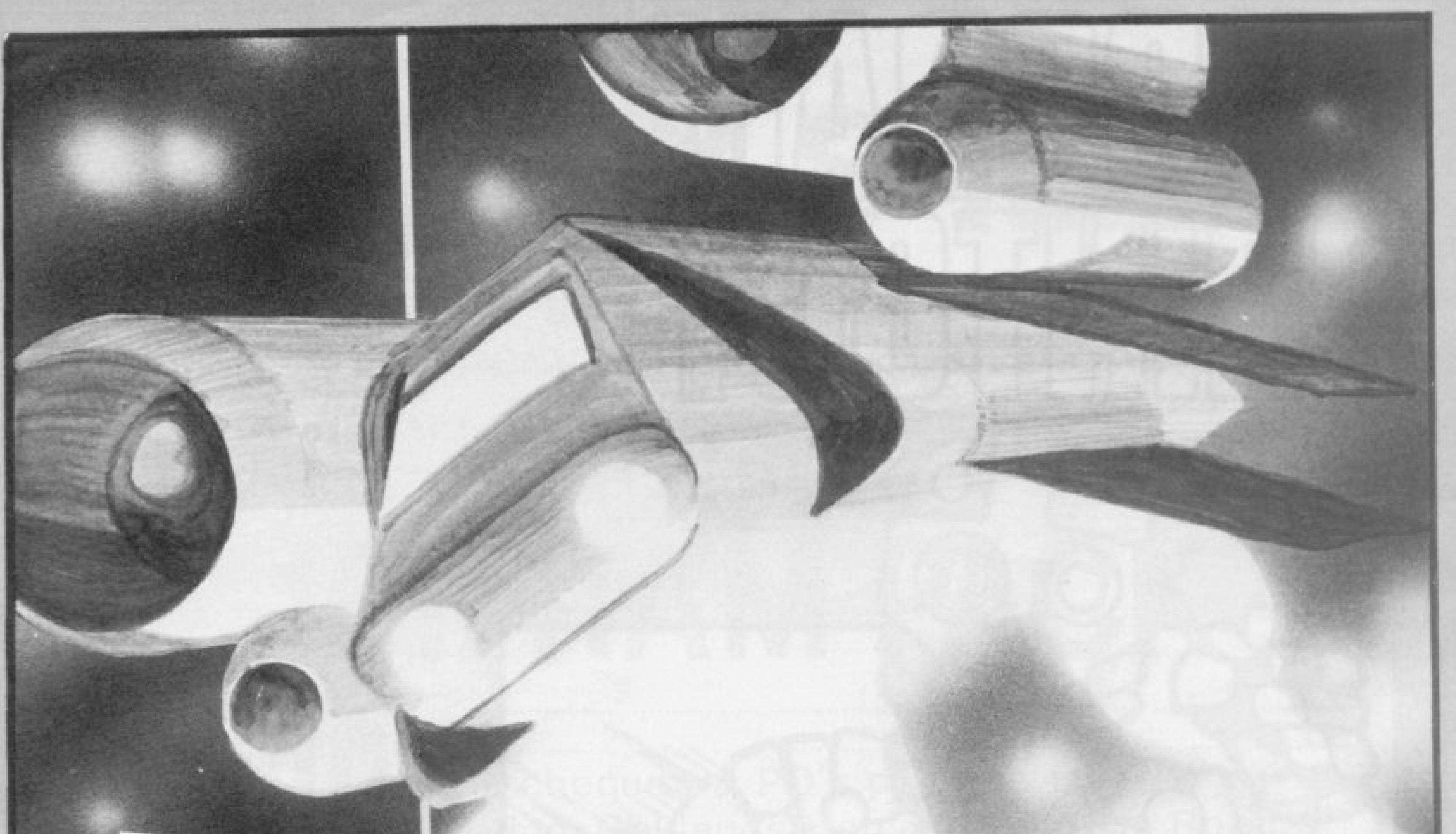
ROBOTS is a variation on the hunting type of game. While appearing simple at first sight, there is a time limit which introduces a degree of difficulty to make the game enjoyable.

The object is to erase five robots in a given time, using the cursor. The formation of the robot means that a fair amount of skill is needed to erase it, moving the cursor with the normal control keys. It is not so difficult, however, that it cannot be mastered with some practice.

If the robot is not erased in the time given it disappears and another appears at a random place on the screen. Up to five appear during each game.

Robots requires slightly less than 2K of memory on the ZX-81 and was sent by David Harwood of Oxford.

```
   1 LET A$=" █ "
   2 LET B$="▚█▞"
   3 LET C$=" ▛▜"
   4 LET A=10
   5 LET B=10
   6 LET C=50
   7 LET E=-1
   8 LET J=-1
   9 LET F=0
  10 LET G=0
  15 PRINT TAB 8;"ROBOT"
  20 PRINT AT 4,0;"YOU MUST TRY
AND DESTROY"
  30 PRINT "5 ROBOTS"
  40 PRINT AT 8,0;"HERE IS A ROB
OT",,A$,,B$,,C$
  50 PRINT AT 13,0;"TYPE ANY KEY
 TO CONTINUE"
  60 IF INKEY$="" THEN GOTO 60
  70 CLS
  80 LET Q$=INKEY$
  85 LET A=A+(Q$="8")-(Q$="5")
  90 LET B=B+(Q$="6")-(Q$="7")
  95 IF C=50 THEN GOSUB 1000
 100 PRINT AT B,A;"█"
 105 PRINT AT B,A;" "
 110 LET C=C+1
 115 GOTO 80
 120 CLS
 125 PRINT "YOU DESTROYED ";E;"
ROBOTS"
 130 STOP
1000 FOR T=0 TO 2
1005 FOR I=0 TO 4
1010 PRINT AT F+T,G,,
1015 LET H=PEEK (I+(PEEK 16398+2
56*PEEK 16399))
1016 IF H>0 AND H<>118 THEN GOTO
 1031
1020 NEXT I
1025 NEXT T
1030 LET E=E+1
1031 LET J=J+1
1033 CLS
1034 IF J=5 THEN GOTO 120
1035 LET F=RND*17
1040 LET G=RND*28
1045 PRINT AT F,G,,A$,,B$,,C$
1050 LET C=0
1055 RETURN
```



LUCA

LUCA is a simple mini-invaders program with only one invader which does not fire missiles but attempts to destroy you by landing on top of your craft. The program which fits on to 1K ZX-81 machines uses key 1 to move your ship left and key 3 to move it right. Use the zero key to fire but you can fire only if the invader is directly above you.

The game ends only when the invader manages to land on any part of your craft. In the meantime, however, each time you repel it by hitting the V at the centre of the craft you score 10 points.

Luca was submitted by Matthew Turner of Woldingham, Surrey and was one of the runners-up in the competition in the April issue.

```
   5 RAND
  10 LET K=2
  20 LET S=0
  30 LET P=8
  40 LET H=INT (RND*18)
  50 LET A$="<V>"
  90 FOR V=INT (RND*15) TO 19
 100 CLS
 110 PRINT AT V,H-1;A$;AT 20,P-1
;"▄█▄"
 120 IF ABS (H)=P AND V>9 AND IN
KEY$="0" THEN GOTO 245
 130 IF INKEY$="1" THEN LET P=P-
(P>K)
 140 IF INKEY$="3" THEN LET P=P+
(P<15)
 150 LET H=H+INT (RND*3)-1
 160 LET H=H+(H<K)-(H>16)
 170 NEXT V
 180 IF ABS (P-H)>2 THEN GOTO 4@
 200 PRINT AT 5,5;"SCORE=";S
 210 PAUSE 500
 230 RUN
 245 FOR N=19 TO V STEP -1
 246 PRINT AT N,P;".";AT 20,P;"▒
"
 247 NEXT N
 248 LET S=S+10
 250 PRINT AT V,H-K;">X+X<"
 270 GOTO 40
```

SQUASH

SQUASH is a simple form of the common amusement arcade games which involve hitting moving objects with a "bat". It is for one player and the main attraction is that it can be played on the 1K ZX-81.

The bat is moved from side using the "1" and "o" keys but because the program is simple the movement is very slow. That can add to the interest of the game because it is necessary to determine the angles at which the object is likely to move so as to be in the correct position to hit it.

It was sent by Michael Clark of Rotherham.

```
  90 GOSUB 500
 100 LET A=4
 110 LET B=A
 120 LET C=30
 130 LET D=1
 140 LET E=D
 150 UNPLOT B,C
 160 LET B=B+D
 170 LET C=C+E
 180 PLOT B,C
 190 IF C>42 THEN LET D=INT (RND
*3-1)
 200 IF C>40 THEN LET E=-E
 210 IF B<4 OR B>17 THEN LET D=-
D
 220 IF C>30 THEN GOTO 250
 230 IF B<>A AND B<>A+1 THEN STO
P
 240 LET E=-E
 250 UNPLOT A,30
 260 UNPLOT A+1,30
 270 IF INKEY$="1" THEN LET A=A-1
 280 IF INKEY$="0" THEN LET A=A+
1
 290 PLOT A,30
 300 PLOT A+1,30
 310 GOTO 150
 500 FOR F=1 TO 9
 510 PRINT AT 0,F;"▀";
 520 NEXT F
 530 FOR F=1 TO 6
 540 PRINT AT F,1;"▌"
 550 PRINT AT F,9;"▐"
 560 NEXT F
 570 RETURN
```



MASTERMIND

```
  10 PRINT "MASTERMIND"
  20 DIM N$(4)
  30 DIM G$(4)
  40 DIM W$(4)
  50 RAND 0
  60 FOR I=1 TO 4
  70 LET N$(I)=CHR$ INT (RND*10+
28)
  80 NEXT I
  90 LET C=0
 100 LET C=C+1
 110 IF C=13 THEN GOTO 350
 120 INPUT G$
 130 IF G$="    " THEN GOTO 350
 140 PRINT G$;" ";
 150 IF G$=N$ THEN GOTO 340
 160 LET W$=N$
 170 FOR I=1 TO 4
 180 IF G$(I)<>W$(I) THEN GOTO 2
20
 190 LET W$(I)="*"
 200 PRINT "B";
 210 LET G$(I)="/"
 220 NEXT I
 230 FOR I=1 TO 4
 240 IF W$(I)="*" THEN GOTO 310
 250 FOR J=1 TO 4
 260 IF I=J OR W$(I)<>G$(J) THEN
GOTO 300
 270 LET G$(J)="?"
 280 PRINT "W";
 290 GOTO 310
 300 NEXT J
 310 NEXT I
 320 PRINT
 330 GOTO 100
 340 PRINT "YES"
 350 PRINT "IT WAS ";N$
 360 STOP
```

NUMBER Mastermind is another variation on the popular **Mastermind** theme. The aim is to guess a four digit number chosen at random and the program will work on a 1K ZX-81.

To use the program just enter your guess in response to the request for input. Twelve guesses are allowed before you are told the correct answer. If you want to give up earlier, press NEWLINE.

The accuracy of each guess is indicated by a black peg (shown as the letter B) for a correct digit in the correct position and a white peg (shown as the letter W) for a correct digit in the wrong position. For example, if the number chosen by the computer was 5678, then a guess of 1618 would score BB and a guess of 1511 would score W.

The program can be made easier by changing line 70. As it stands, each digit can be 0-9 but if changed to (RND*5+28) each digit would be in the range zero to four etc.

Number Mastermind was sent by R Newman of Kettering, Northamptonshire.

HISTOGRAM is for a 16K ZX-81 and is a neat example of how to use the computer to draw bar charts. It can handle up to 28 items of data and its appearance is helped by the bars being of variable width, according to the number, so that the available space is best filled.

Bars are produced in two different graphic characters to make them distinct and there is provision for a heading above the histogram, as well as labels for the two axes of the graph. Data is scaled automatically to fit the vertical limits of the screen and any positive numbers can be handled.

A vertical scale, using integer numbers, is drawn automatically at the left-hand side of the histogram, so that approximate values can be read from the chart.

The histogram drawing section of the program is in lines 9000-9900, while lines 100-800 simply get the data required. The histogram routine can be incorporated into other programs or for plotting more than one set of data.

The data required for the plotting routine is:

T$, X$, Y$—title, x—axis label, y—axis label

N—number of intervals on horizontal axis

Y(1)–Y(N)—data to be plotted.

Histogram was sent by R Newman of Kettering, Northamptonshire.

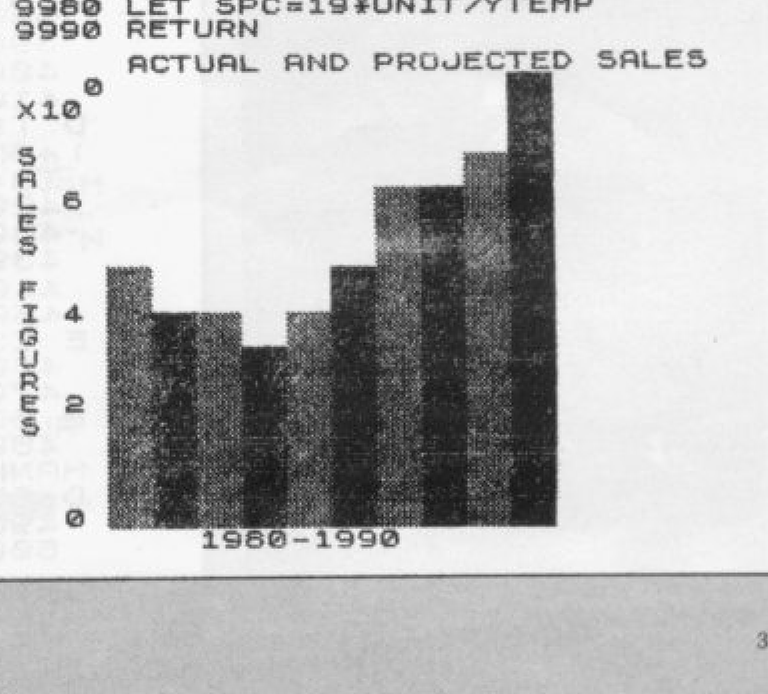


```
 100 DIM Y(28)
 110 DIM T$(26)
 120 DIM X$(16)
 130 DIM Y$(16)
 200 LET A$="HISTOGRAM"
 210 FOR I=1 TO 17
 220 PRINT AT I,2;A$(1 TO I-(I-9
)*(I>9)*2)
 230 NEXT I
 240 PRINT AT 9,13;"PLOTTING ROU
TINE"
 250 PRINT AT 20,10;"BY R NEWMAN
."
 260 PAUSE 150
 400 CLS
 410 PRINT "PLEASE GIVE HISTOGRA
M TITLE,"
 420 PRINT "X AXIS LABEL,AND Y A
XIS LABEL,IFREQUIRED (OTHERWISE
JUST PRESS"
 430 PRINT "NEWLINE).TITLE CAN B
E UP TO 26"
 440 PRINT "CHARACTERS LONG, AXI
S LABELS UP TO 16 CHARATERS."
 450 PRINT AT 7,0;"TITLE? "
 460 INPUT T$
 470 PRINT T$
 480 PRINT AT 10.0;"X AXIS (HORI
ZONTAL) LABEL?"
 490 INPUT X$
 500 PRINT X$
 510 PRINT AT 13,0;"Y AXIS (VERT
ICAL) LABEL?"
 520 INPUT Y$
 530 PRINT Y$
 540 PRINT AT 16,0;"NO. OF INTER
VALS ALONG X AXIS - IE. NO. OF B
ARS IN HISTOGRAM?"
 550 PRINT "PERMITTED RANGE = 2
TO 28."
 560 INPUT N
 570 IF N<2 OR N>28 THEN GOTO 55
0
 580 PRINT N
 590 PAUSE 150
 600 CLS
 610 PRINT "OK. NOW ENTER Y VALU
ES AT EACH  INTERVAL (HEIGHT OF
BAR).. ENTER"
 620 PRINT "THEM ONE AT A TIME F
ROM 1 TO ";N
 630 FOR I=1 TO N
 640 INPUT Y(I)
 650 PRINT AT 4+I-14*(I>14),15*(
I>14);Y(I)
 660 NEXT I
 670 PRINT AT 20.0;"ANY MISTAKES
? ";
 680 INPUT A$
 690 IF A$<>"YES" AND A$<>"Y" TH
EN GOTO 9000
 700 CLS
 710 PRINT "EACH VALUE WILL BE P
RINTED OUT. IF OK, JUST PRESS NE
WLINE."
 720 PRINT "TO CORRECT AN ERROR,
RETYPE NEW  VALUE."
 730 FOR I=1 TO N
 740 PRINT AT 4+I+14*(I>14),15*(
I>14);Y(I)
 750 INPUT A$
 760 IF A$="" THEN GOTO 800
 770 LET Y(I)=VAL A$
 780 PRINT AT 4+I+14*(I>14),15*(
I>14);"        "
 790 PRINT AT 4+I+14*(I>14),15*(
I>14);Y(I)
 800 NEXT I
9000 REM *HISTOGRAM ROUTINE**
9010 REM ********************
9020 REM **FIND MAX Y VALUE**
9030 LET YMAX=0
9040 FOR I=1 TO N
9050 IF Y(I)>YMAX THEN LET YMAX=
Y(I)
```

HISTOGRAM



```
9060 NEXT I
9070 REM **** SCALE Y VALUES*
9080 DIM W(N)
9090 FOR I=1 TO N
9100 LET W(I)=INT (Y(I)*38/YMAX)
9110 NEXT I
9120 REM *WIDTH OF BARS******
9130 LET XF=1+(N<15)+(N<10)+(N<8
)+(N<6)
9140 REM **UNITS FOR Y AXIS**
9150 LET YTEMP=YMAX
9160 LET EXP=0
9170 IF YTEMP>1 AND YTEMP<=10 TH
EN GOTO 9190
9180 GOSUB 9800+(YTEMP<=1)*100
9190 GOSUB 9960
9200 REM *** DRAW HISTOGRAM**
9210 CLS
9220 PRINT AT 0,18-(LEN T$/2);T$
9230 FOR I=1 TO LEN Y$
9240 PRINT AT 3+I,0;Y$(I)
9250 NEXT I
9260 PRINT AT 21,24-LEN X$;X$
9270 FOR I=0 TO 4
9280 IF 20-SPC*I>2 THEN PRINT AT
 20-SPC*I,2;I*UNIT
9290 IF I*UNIT<YTEMP THEN NEXT I
9300 PRINT AT 2,0;"X10"
9310 PRINT AT 1,3;EXP
9320 LET BL=0
9330 FOR I=1 TO N
9340 IF W(I)=0 THEN GOTO 9470
9350 LET PP=20
9360 LET Z$=("▓" AND BL)+("▓" AN
D NOT BL)
9370 IF W(I)=1 THEN LET Z$=("▓"
AND BL)+("▓" AND NOT BL)
9380 FOR J=1 TO XF-1
9390 LET Z$=Z$+Z$(1)
9400 NEXT J
9410 PRINT AT PP,4+(I-1)*XF;Z$
9420 IF W(I)<2 THEN GOTO 9470
9430 LET W(I)=W(I)-2
9440 LET PP=PP-1
9450 IF W(I)=1 THEN GOTO 9370
9460 GOTO 9410
9470 LET BL=NOT BL
9480 NEXT I
9490 STOP
9500 REM ***********************
9800 REM **YMAX>10**************
9810 LET YTEMP=YTEMP/10
9820 LET EXP=EXP+1
9830 IF YTEMP>10 THEN GOTO 9810
9840 RETURN
9900 REM **YMAX<=1**************
9910 LET YTEMP=YTEMP*10
9920 LET EXP=EXP-1
9930 IF YTEMP<=1 THEN GOTO 9910
9940 RETURN
9960 REM **UNITS FOR Y AXIS***
9970 LET UNIT=1+(YTEMP>5)
9980 LET SPC=19*UNIT/YTEMP
9990 RETURN
```



```
   0 REM ZX-IATRIST
  10 GOTO 560
  20 INPUT A$
  30 IF A$="" THEN GOTO 20
  40 IF A$="GO AWAY" OR A$="GOOD
BYE" THEN GOTO 540
  50 RAND
   0 REM  BY DILWYN JONES
  60 IF PEEK 16442<5 THEN CLS
  70 IF PEEK 16436+256*PEEK 1643
7<50500 THEN GOTO 440
  80 PRINT
  90 PRINT A$
 100 IF A$(LEN A$)="?" THEN LET
A$=A$( TO LEN A$-1)
 110 FOR A=1 TO 12
 120 LET T$=K$(K(A) TO K(A+1)-1)
 130 LET T=LEN T$
 140 FOR B=1 TO LEN A$-T+1
 150 IF T$=A$(B TO B+T-1) THEN G
OTO 270
 160 NEXT B
 170 NEXT A
 179 REM  NO KEYWORD FOUND
 180 LET R=INT (RND*6)
 190 IF R=0 THEN PRINT "WHY DO Y
OU SAY THAT"
 200 IF R=1 THEN PRINT "GO AND P
RETEND YOU ARE A LEMMING"
 210 IF R=2 THEN PRINT "OH SHUT
UP"
 220 IF R=3 THEN PRINT "PLEASE S
AY SOMETHING SENSIBLE"
 230 IF R=4 THEN PRINT "IS THAT
SO"
 240 IF R=5 THEN PRINT "TELL ME
MORE ABOUT THAT"
 250 PRINT
 260 GOTO 20
 270 LET R=(A-1)*2+1+(1 AND RND<
.5)
 280 PRINT R$(R(R) TO R(R+1)-1);
 290 IF R$(R(R+1)-1)=" " THEN GO
TO 320
 300 PRINT
 310 GOTO 20
 319 REM  CONJUGATE
 320 LET B$=A$(B+T+(1 AND A<11)
TO )
 330 FOR A=1 TO 4
 340 LET T$=("MY" AND A=1)+("YOU
R" AND A=2)+("ME" AND A=3)+("YOU
" AND A=4)
 350 LET T=LEN T$-1
 360 FOR B=1 TO LEN B$-T
 370 IF T$=B$(B TO B+T) THEN GOT
O 410
 380 NEXT B
 390 NEXT A
 400 GOTO 420
 410 LET B$=B$( TO B-1)+("MY" AN
D T$="YOUR")+("YOUR" AND T$="MY"
)+("ME" AND T$="YOU")+("YOU" AND
 T$="ME")+B$(B+T+1 TO )
 420 PRINT B$
 430 GOTO 20
 439 REM  TIME UP
 440 CLS
 450 PRINT "I AM AFRAID YOUR TIM
E IS UP";
 460 LET R=INT (RND*3)
 470 IF R=0 THEN PRINT " AND I A
M SO GLAD."
 480 IF R=1 THEN PRINT ".",,," T
HANK YOU, ";N$;". THAT WAS A GOO
D SESSION."
 490 IF R=2 THEN PRINT "."
 500 PRINT
```

ZX-IATRIST

```
 510 PRINT "ANYBODY ELSE WANT CO
NSULTATION?";TAB 10;"(Y OR N)"
 520 INPUT A$
 530 IF CODE A$=CODE "Y" THEN GO
TO 670
 540 PRINT ,,"GOODBYE THEN."
 550 STOP
 559 REM  DATA INITIALISATION
 560 PRINT AT 10,3;"PLEASE WAIT
FOR A MOMENT";TAB 3;"WHILE I GET
 MYSELF READY"
 570 DIM R(25)
 580 FOR A=1 TO 25
 590 LET R(A)=VAL "0010260450660
88106128151163177192208229242256
277297309330358385388403422430"(
(A-1)*3+1 TO (A-1)*3+3)
 600 NEXT A
 610 LET R$="WHY DO YOU THINK YO
U ARE I WOULD HATE TO BE WOULD Y
OU LIKE TO BE WHY DO YOU THINK I
 AM WOULD YOU LIKE TO PLEASE EXP
LAIN WHY NOTWHY DO YOU ASK IF I
AM NO I AM NOT DEFINITELY NOTNO
YOU CAN NOT OF COURSE I CAN I DO
UBT IF YOU COULD WHY SHOULD I NO
 I WILL NOT TELL ME WHY YOU WANT
 WHAT MAKES YOU WANT OH, POOR YO
UA LOT OF PEOPLE FEEL THE ZX81 I
S A GREAT COMPUTERWOULD YOU LIKE
 TO BE A ZX81WHYSO WHAT IF YOU I
 DO NOT CARE IF I WHO, ME "
 620 LET K$="I AMYOU AREI DO NOT
ARE YOUCAN ICAN YOUWILL YOUI WAN
TI FEELZX81I YOU "
 630 DIM K(13)
 640 FOR A=1 TO 13
 650 LET K(A)=VAL "0105122027323
9475359636569"((A-1)*2+1 TO (A-1
)*2+2)
 660 NEXT A
 669 REM  INTRODUCTION
 670 CLS
 680 PRINT TAB 10;"ZX-IATRIST";T
AB 10;"----------"
 690 PRINT ,,"HELLO, I AM YOUR C
OMPUTER"
 700 PRINT "PSYCHIATRIST.YOU CAN
 TELL ME"
 710 PRINT "YOUR PROBLEMS AND WO
RRIES IN THE"
 720 PRINT "STRICTEST CONFIDENCE
, BUT DO NOT"
 730 PRINT "TAKE MY COMMENTS TOO
 SERIOUSLY."
 740 PRINT ,,"FIRST, PLEASE ENTE
R YOUR NAME SO"
 750 PRINT "THAT I KNOW WHO I AM
 TALKING TO."
 760 INPUT N$
 770 RAND
 780 PRINT ,,N$
 790 LET A=INT (RND*2)+1
 800 PRINT ,,("THAT IS AN AWFUL
NAME" AND A=1)+("WHAT A NICE NAM
E" AND A=2)
 810 PRINT ,,"HOWEVER, PRESS ""N
EWLINE"" TO"
 820 PRINT "CARRY ON."
 830 INPUT A$
 840 POKE 16436,255
 850 POKE 16437,255
 860 CLS
 870 PRINT "PLEASE TELL ME YOUR
PROBLEM"
 880 GOTO 20
9899 REM  LOAD AND GO ROUTINE
9900 SAVE "ZX-IATRIST"
9910 RUN
```

AN INTERESTING concept with a 5K program for the ZX-81 is **ZX-Iatrist.** Though the program, so a load and go task is to carry on a kind of conversation with the user. It recognises a few words and phrases and chooses suitable, or not so suitable, replies, sometimes making a direct reference to the statement entered.

The range of words ZX-Iatrist recognises is not great but, as it is based on very general and commonly-occurring words, there is a good chance that one of them exists in a sentence.

When run, the program takes two seconds to set up the data for the program so a load and go routine is included, so that initialisation takes place immediately. Running the program causes it first to ask for your name and then compliments or insults you, depending on whim, and when the conversation starts, you enter your reply, comment or question.

Brief sentences are better, as they run faster. The program scans the sentence for words it recognises by extracting substrings from K$ and when it finds a match selects a suitable reply substring from R$.

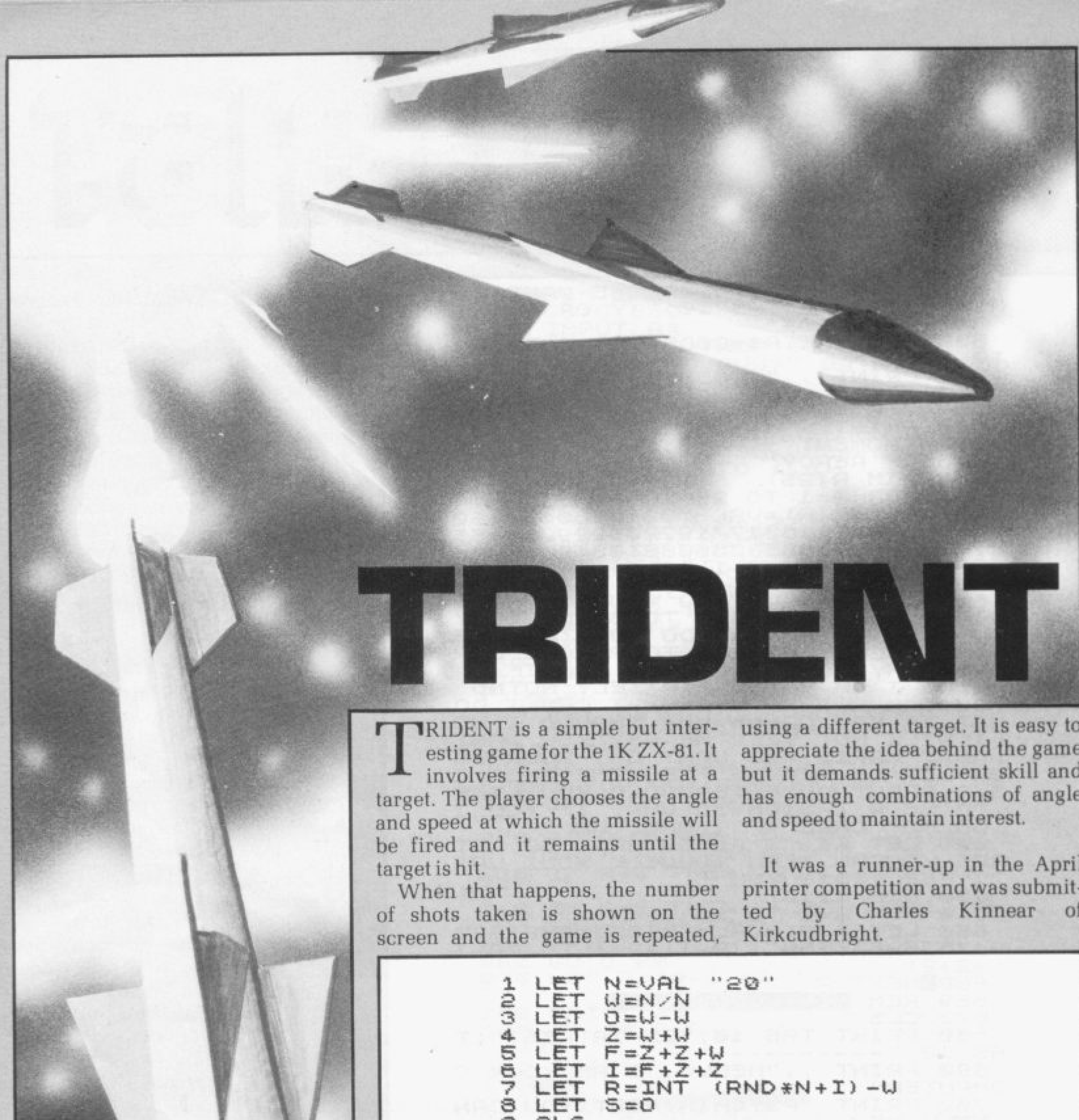
If the last character of the reply substring is a space it tells the computer that more information is needed to finish the reply and that is extracted from the sentence you entered.

The entire reply may take anything from one second to half a minute to appear. You can reduce that time by switching the program from slow to fast and back again at certain points in the program, if you do not mind losing the screen for a time. To install this add the following lines:

```
95 FAST
20 SLOW
21 INPUT A$
```

When entering the listing, take particular care with lines 560-660 and especially with lines 610 and 620, where the amount and position of the spaces is critical.

ZX-Iatrist was sent by Dilwyn Jones of Bangor, North Wales as an entry in the competition.



TRIDENT

TRIDENT is a simple but interesting game for the 1K ZX-81. It involves firing a missile at a target. The player chooses the angle and speed at which the missile will be fired and it remains until the target is hit.

When that happens, the number of shots taken is shown on the screen and the game is repeated, using a different target. It is easy to appreciate the idea behind the game but it demands sufficient skill and has enough combinations of angle and speed to maintain interest.

It was a runner-up in the April printer competition and was submitted by Charles Kinnear of Kirkcudbright.

```
   1 LET N=VAL "20"
   2 LET W=N/N
   3 LET O=W-W
   4 LET Z=W+W
   5 LET F=Z+Z+W
   6 LET I=F+Z+Z
   7 LET R=INT (RND*N+I)-W
   8 LET S=O
   9 CLS
  10 LET S=S+W
  11 SCROLL
  12 PRINT "▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀▀
▀▀▀▀▀▀▀▀▀▀▀";AT N+W,R;"▒"
  13 LET X=O
  14 LET Y=O
  15 PRINT AT O,O;"ANGLE?"
  16 INPUT A
  17 LET A=A*PI/I/N
  18 PRINT AT O,O;"SPEED"
  19 INPUT V
  20 PRINT AT O,O;"          "
  21 LET E=V/F*SIN A
  22 IF E<Z/N THEN GOTO I
  23 FOR T=O TO E+W/N/N STEP E/N
*Z
  24 LET X=V*Z/N*T*COS A
  25 LET Y=T*(E-T)+W/N
  26 IF X>(N+I)*Z OR Y>=F*I-Z TH
EN GOTO N+I
  27 PLOT X,Y+W
  29 NEXT T
  30 IF INT ((X+W/Z)/Z)<>R THEN
GOTO I
  31 PRINT AT N+W,R-Z;"▚BOOM▞";A
T N,R-W;"▚▌ ▗";AT I,I;S;" SHOT"+
("S" AND S>W)
  32 PAUSE N*Z
  33 RUN
```

ZX81 owners



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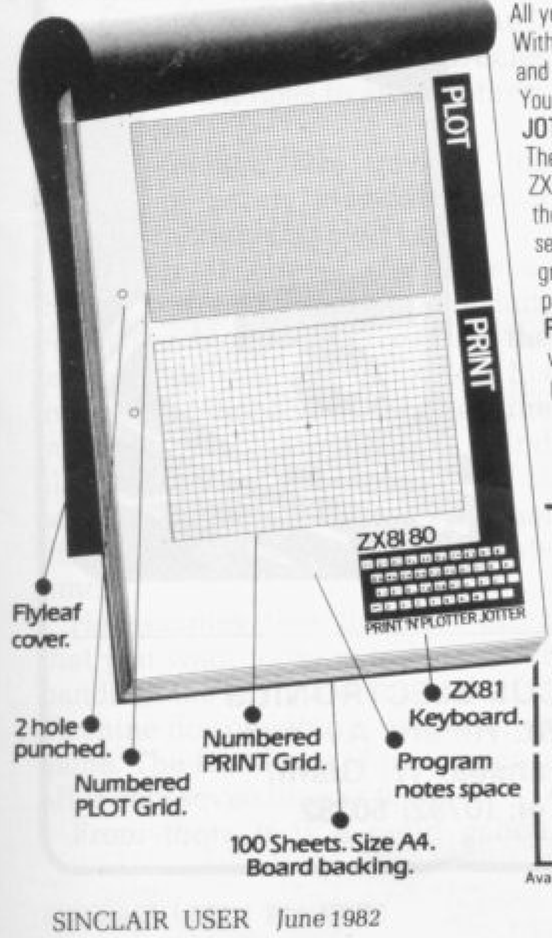
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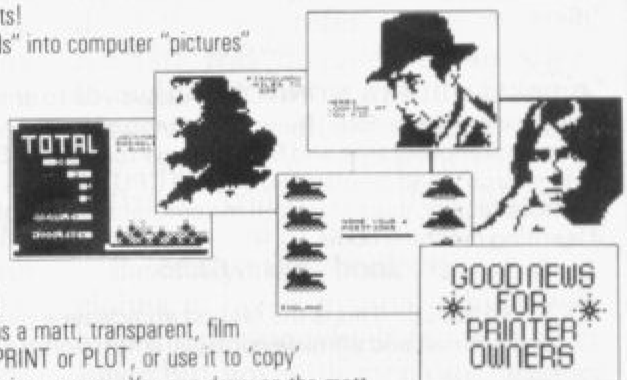
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Basic guide

Tom Vests digs into the ZX avalanche

"THERE seems to be an infinite market for books on how to program in Basic. No matter how many books are published, there seems to be room for just 10 more".

This is one of Mark Charlton's comments in a chapter called What can you do with it? in his *Gateway Guide to the ZX-81 and ZX-80* and anyone looking at the avalanche of books on the Sinclair is seeing only a small total of the titles which could be of interest to the Sinclair user.

A sure best-seller would be a guide to all the books but it would be likely to be out-of-date before anyone had a chance to buy it.

To return to the question of what you can do with your Sinclair, books on the subject often reveal more about the author than anything else. In Charlton's case it is clear that he regards the machine and its programming as ends in themselves.

His next most enjoyable use for the Sinclair is writing about it and, presumably, talking about it. His chapter on uses devotes as much space to the topic of writing articles and books as it does to all the others combined.

That chapter also reveals the dangers of listing magazines as it does not includes *Sinclair User*.

Charlton is one of the idiosyncratic writers on the Sinclair. Following his guide gives you the feeling that you are following his own experiences with the machine but with the mistakes and blind alleys taken out and the addition of occasional warnings about potential disasters included at the appropriate time.

He assumes that the first thing that you want to do is to have your hands on the keyboard and make the machine do something, preferably a game. The first lines of code appear after only seven lines of text.

From there it is a rapid gallop, with Charlton bringing in the standard commands, explaining them and allowing the reader to try them. On the whole, this approach should be encouraged. Programming can be a hard slog but it should be fun and rewarding as well.

Charlton says that he assumes no knowledge on the part of the reader but he is really addressing himself to the person who feels confident at hooking-up the machine and who has read at least the first few pages of the Sinclair manual.

It is unlikely that the totally inexperienced person, who after all has probably bought the Sinclair to find out what computers are about, could otherwise make much sense of the instruction on the first page of 'Run this and return to the book'.

That small quibble apart, I found the *Gateway Guide* interesting and worthwhile. Charlton goes a long way to sharing his own delight in the Sinclair with his reader.

In particular, his light hand with the problems of self-discipline in programming makes the necessary point that it is easier to do things correctly the first time. Always a gentleman, Charlton gives credit to the book which introduced him to the ideas he is putting forth.

In *The Explorers Guide to the ZX-81*, Mike Lord follows the same approach but assumes that the reader has read the Sinclair manual.

From then Lord acts as a guide through possibly hostile territory, pointing-out the snakes of programming and the ladders for the novice. He also believes in the use of games to learn the wrinkles of programming the Sinclair, or as he puts it, 'the mysteries of this marvellous machine".

Lord goes beyond the Sinclair in giving a guide to other forms of Basic programming, plus an introduction to the Matterhorn of programming: using machine code. In his light-hearted way he makes it seem the easy and natural thing to do.

Using machine code however, is easy only to a minority of people. At the same time it is not as difficult as some people regard it.

It is possible to go through life without deviating from Basic and getting just as much satisfaction from the Sinclair but for anyone who really wants to get to know their machine, a certain familiarity with machine code is necessary and Lord provides enough information and examples to provide it.

With a section for the person whose hands itch for the soldering iron, Lord's book lives up fully to its name. It is a valuable book.

For those who want to squeeze the last bit from their Sinclair, machine code programming is essential. One of the best books from which to learn it is Toni Baker's *Mastering Machine Code on Your ZX-81*.

In very small print the cover has 'or ZX-80'. Suspicious buyers might think that any reference to the first Sinclair was included as an afterthought but this would do Baker a disservice for all through the book she makes a clear distinction between codes for the different machines and ROMs.

Basically the book is what it claims to be—a manual which will take the person who is familiar with Basic but not with machine code to the point of making real use of the latter.

Mark Charlton: The Gateway Guide to the ZX-81 and ZX-80. (Database Consultancy, 105 Fairholme Avenue, Gidea Park, Romford, Essex.)

Mike Lord: The Explorers' Guide to the ZX-81. (Timedata, 57 Swallowdale, Basildon, Essex.)

Toni Baker: Mastering Machine Code on Your ZX-81. (Interface, 44-46 Earls Court Road, London W8.)





Elspeth Joiner talks to Nigel Searle, new chief of Sinclair's Computer Division

Plotting a course for growth

THE launch of the Spectrum is only a part of the development plans of the Sinclair Research computer division in the coming year. The company also intends to produce another small computer, market a full range of peripherals and software for all its computers, and expand overseas and into the educational market.

The man behind the ambitious expansion plans is the newly-appointed head of the division, Nigel Searle.

"I expect we will launch at least one new computer which will not replace the ZX-81, but which will sell alongside the ZX-81 and be the beginning of a range of computers", he said.

"By the end of the year they will be fully-supported in terms of peripherals and software. We have already developed a mass storage device which is of our own design and that will be announced later this year".

He added that in future Sinclair intends to launch new computers with a full range of software.

Of the educational market, Searle said: "Many schools have a ZX-81, but the price of them is such that many schools ought to have 20 or 30 of them. We hope to penetrate that market in the U.K. and elsewhere".

This ties with his plans for overseas growth. The company is in the middle of searching for foreign distributors.

"We expect our overseas sales to increase substantially", he said.

Searle became head of the computer division four months ago and has a long association with Clive Sinclair. He first joined him in the Sinclair Radionics company 10 years ago designing pocket calculators. He then moved to the U.S. first in California and later in New York, where he was responsible for promoting the company's calculators and watches.

He stayed with the company until 1977 when he left. "The calculator business was not doing too well and also it was not really the same company once the National Enterprise Board was involved", he said.

Two years later Clive Sinclair formed Sinclair Research, launched the ZX-80 and Searle rejoined him. He ran the U.S. office in Boston, concentrating on selling the ZX-80 and 81 until taking-up his new job.

Software is an area in which Searle is particularly interested. The company has begun a software development project which should build the library to 200 programs by the end of the year.

"They will be available only through W H Smith, 26 to start with, which is just the tip of the iceberg, covering games, education and some business. It is an area we have neglected in the past but we have spent time getting together a wide range of software for the ZX-81".

Searle has been involved closely with the launch of the Spectrum and he has decided to continue Sinclair's unusual marketing strategy of concentrating on mail order.

"With minor variations we are launching our new products the same way we always have done", he said, but added, that "there are no plans at present for putting the new machine into W H Smith, which is Sinclair's only retailer".

He said the reason was that "not many others are selling so many computers as we are. We have sold

(continued on page 44)





(continued from page 43)

far more computers by mail order than anyone who has sold through stores".

He added that the original idea behind the mail order decision was that when Sinclair first went into the computer market there was no obvious retail outlet for a personal computer.

"It does not occur to me, or anybody else, that Boots, Currys, Rumbelows, would sell a computer.

"It also makes good sense financially to sell through mail order. We do not have to give a discount to retailers which you normally have to do".

The promotion of a new product through retail distribution can cost so much that the price of the product has to be raised by 50 percent.

Heavy advertising is still essential and Searle again adopts an unusual policy by not having a pre-determined budget.

"We are willing to spend as much on advertising as will produce a profitable number of sales", he explained. Last year the cost was slightly more than £5 and in 1982 it looks as if it will be more than £10 million.

Where that is spent depends on the product with advertising in the technical press computer journals, particularly the magazines, and the Sunday magazines.

"So far we have had products which have been of interest to both the specialist computer market and the general enthusiast market but we might well have products in the future which would be of interest only to your serious computer user".

For the Spectrum, Searle is concerned not only with selling the machine but also with persuading people that is it better than rival pro-



ducts. "We would not introduce a computer unless it was significantly different from our existing one. It will appeal to a much wider market and we will be trying to persuade people to buy it in preference to other products," he said.

His return to Britain has made life much more hectic than it was when he was in Boston selling the two ZX computers.

"So far working here has been a bit like jumping on a train which is passing at about 60mph. It seems as though there are many things to be done".

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And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, *and* to drive the new ZX Printer.



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- 1K-byte RAM expandable to 16K bytes with Sinclair RAM pack.
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You'll be surprised how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 700 mA at 9 V DC nominal unregulated (supplied with built version).

Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.



puter-



Available now- the ZX Printer for only £59.95

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumerics *and* highly sophisticated graphics.

A special feature is COPY, which prints out exactly what is on the whole TV screen without the need for further intructions.

At last you can have a hard copy of your program listings – particularly useful when writing or editing programs.

And of course you can print out your results for permanent records or sending to a friend.

Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your computer – using a stackable connector so you *can* plug in a RAM pack as well. A roll of paper (65 ft long x 4 in wide) is supplied, along with full instructions.

16K-byte RAM pack for massive add-on memory.

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Machine code complex

In the second of his three articles on machine code, Mike Biddell works out a more complex routine which could have a number of applications.

IN PART one, we developed some of the basic machine code concepts and produced a machine code loader which poked the code into a REM statement at line one in the Basic programme.

A very simple four-byte program was stored in the REM statement and called with USR.

The machine code loader will now be used to develop a more complex machine code routine, which will be a useful addition to your subroutine library.

At this stage, we will not be too ambitious and it is probably realistic to choose the example we mentioned in part one, scroll down. That is to say, we will attempt to write a machine code routine which, when called once, moves every line on the screen down one, leaving the top line blank and making the bottom line disappear. This could have any number of applications either in games or in a rudimentary work processor.

You will need the 16K RAM pack added at this stage. When the screen is full, which is the case with most games, the 1K RAM is generally insufficient and the addition of the 16K RAM pack automatically reserves space for a full display. With a collapsed display file, the coding of our scroll down program become difficult to understand.

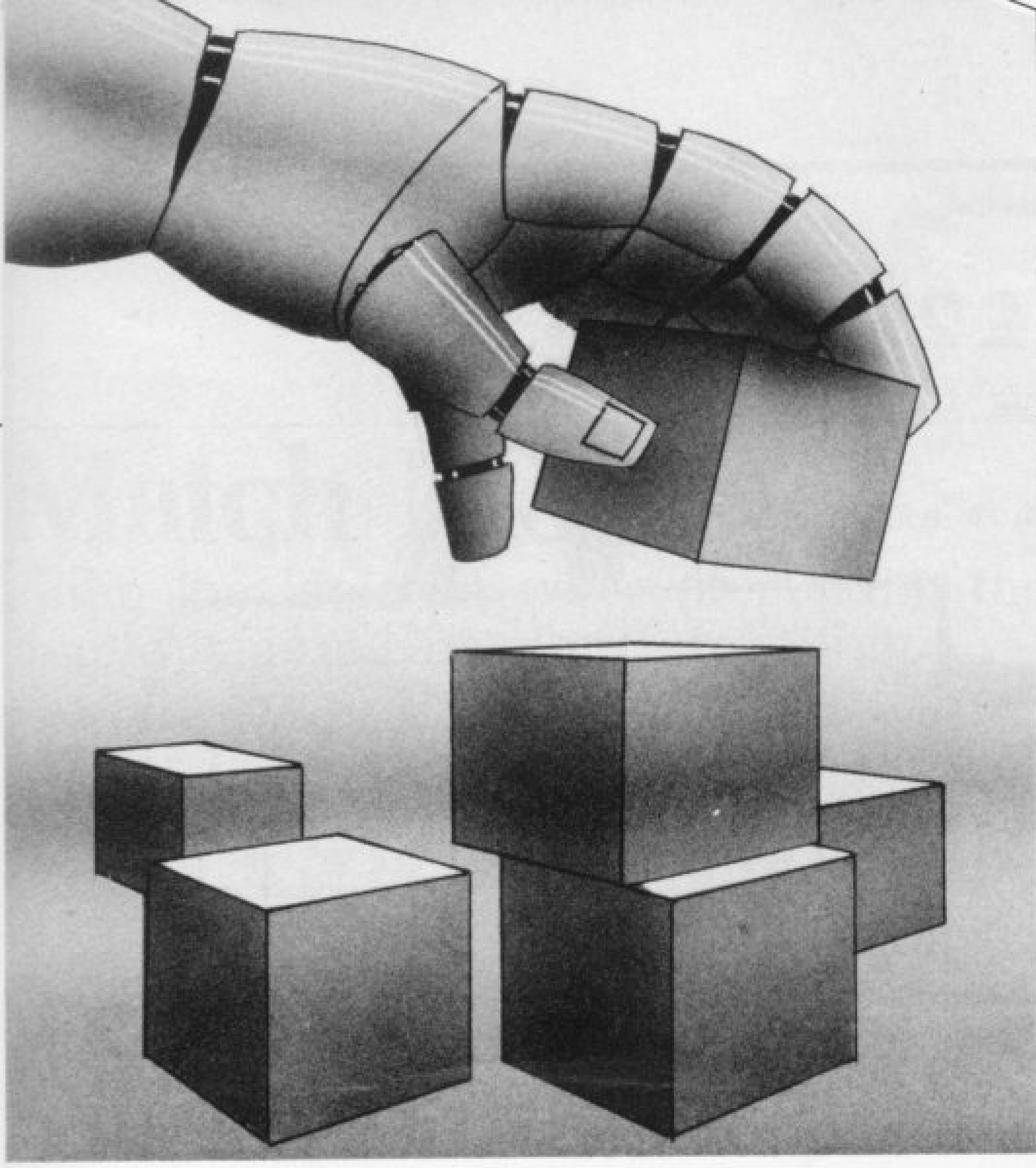
The 1K machine operates with no memory reserved for display and builds-up the display file as you print characters on the screen.

To start writing a machine code routine we first need some knowledge of the registers available in the Z-80 chip. A register is a place/device which can hold one instruction or piece of data (byte), where we can work on it. It is stored in the register as a series of eight zeros or ones (bits) in any combination, for example, 00001100 is the bit pattern for increment (add one to) the 'C' register. For this reason, the Z-80 chip is known as an eight-bit processor.

The registers we will mainly be using are the accumulator (A), H, L, D, E, B, C, and the flag (F) register. The accumulator and flag registers are special-purpose registers; the other six are very similar, can be

Figure 1: MACHINE CODE SCROLL DOWN FOR 16K ZX-81

STEP	HEX CODE	DECIMAL CODE	NEMONIC	COMMENT
1	2A 0C 40	42 12 64	LD HL (40 0C)	Load the display file. Start address into HL.
2	11 72 02	17 114 2	LD DE, 626 DEC	Size of screen to be scrolled.
3	19	25	ADD HL, DE	Point HL at last character on screen to be scrolled.
4	E5	229	PUSH HL	Temporarily store this address on the stack.
5	06 21	6 33	LD B, 33 DEC	Load B register with V.D.U. line length.
6	23	35	INC HL	Point HL to one line below by incrementing.
7	10 FD	16 253	DJNZ−1	HL 33 times.
8	E5	229	PUSH HL	Temporarily store this address on stack.
9	D1	209	POP DE	Put the HL value off the stack into the DE register.
10	E1	225	POP HL	Bring back the original HL value into HL
11	0E 13	14 19	LDC, 19 DEC	No of lines to scroll.
12	06 21	6 33	LD B 33 DEC	Length of line including line end marker.
13	7E	126	LD A, (HL)	Load A, with the character code pointed to by the HL pair.
14	12	18	LD(DE), A	Load the position pointed to by the DE pair with the character code in A.
15	1B	27	DEC DE	Point DE at the next position.
16	2B	43	DEC HL	Point HL at the next character to be copied down.
17	10 FA	16 250	DJNZ−4	Repeat above four steps thirty three times (one line).
18	0D	13	DEC C	Reduce line count by 1.
19	20 F5	32 245	JRNZ−7	Jump back to step 12 if line count not zero.
20	C9	201	RET	Return to BASIC programme.



interchanged and used as pairs such as HL, DE, BC.

They can be used to hold addresses pointing to various parts of the computer memory, because you need 16 bits to address any meaningful quantity of memory.

The accumulator works like any one of the six general-purpose registers but can also be used to perform arithmetical and logical jobs, whereas the general-purpose registers cannot.

The flag register generally is used to tell us whether the result of an operation is zero or not. Testing one bit in this register will tell us, for instance, if subtracting one from the C register resulted in zero. This is used frequently and is very useful.

In the ZX-81, the system shifts the area of memory used for the display; but being a very courteous computer it keeps us constantly informed of where it has gone, by putting its new start address (two bytes – sixteen bits) in system variables 16396 and 16397. This is presented as the least significant bit at 16396 (lowest part of the number, i.e. up to 256) and the most significant bit second at 16397 (product of 256).

The number stored at 16397 must therefore be multiplied by 256 to give the higher order part of the address, so to locate the D file address we must evaluate:

PEEK (16396) + 256 * PEEK (16397).

At any time, we can locate the start address of the D file by using no line number and PRINT followed by the foregoing expression.

We must now think how we will achieve scroll down in general terms, forgetting about coding for the minute. We shall proceed now by writing in words how we expect the programme to flow, although we may have to alter our concept later.

Begin by finding the address of the start of the display file and store it in a register pair and then find the address of the end of the display file, or as much of the display file as we wish to scroll and also store it in a register pair, HL registers say. Load the DE register pair with the address directly below HL on the screen; this will involve adding decimal 33 to the HL address, since there are 33 addresses per screen line.

Next shift the character at the position pointed to by HL to the position pointed to by DE. (Repeat for one whole screen line). This will print the whole of the line scanned by HL to the positions below scanned by DE. Shift the addresses of HL and DE up the screen by one line and repeat.

Then repeat until the whole screen has been processed in this way. Each line on the screen has now been copied to the line below so return to basic (RET).

The completed routine is shown in Figure 1. It was produced by using the rough list flowchart, presented above and the Mostek Z-80 programming manual. It uses the simple programming elements we described in the first article.

To understand fully the step from flow chart list to the finished program, you should study Figure 1 and the comments in depth, until you can understand to your satisfaction what is happening.

We now need to enter the code into your computer to test that it works correctly. Ensure you have your 16K RAM attached or it will not work.

Enter the machine code loader we developed last time, RUN it and type in the decimal code, entering NEWLINE after each number.

After entering the last code, enter MM NEWLINE to break out of the program. Now delete all lines except one and three and add lines 10, 20, 30, and 40 as shown in Figure 2, the scroll down test program.

When you now RUN the program, "HELLO" should be printed in the centre of the screen and, after a short delay, it should move down one line. It works – congratulations.

Save this program on tape, since in the third article we will explain how the routine might be called from a Basic program to produce an interesting game.

Figure 2: SCROLL DOWN TEST PROGRAM

```
   1 REM E£RND)?▪; FAST ▞57( CLE
AR FAST SGN LPRINT :<▞5$4 PRINT
TAN MMMMMMMMMMMMMMMMMMMMMMMMMMMM
MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
MM
   3 LET T=16514
  10 PRINT AT 11,12;"HELLO"
  20 FOR I=0 TO 50
  30 NEXT I
  40 LET A=USR (T)
```

Match Moves

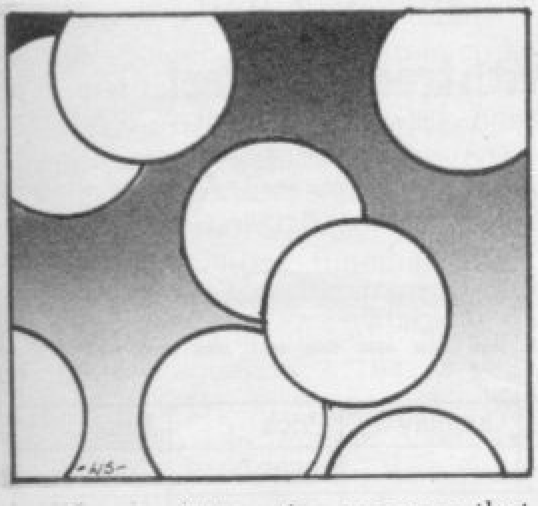
Philip Joy looks at ways of making the simple game of Nim more interesting.

I include this month details of a game called **Nim,** which you can try and write yourselves, I shall include a version next month of my own. I also include portions of a letter which I received concerning ZX-81chess games against a dedicated chess computer.

Nim is a very old game which has very easy rules. There are many versions but I shall use the shortest. It consists of a pile of matches/counters, of some random amount, say one to 100. Two players then take turns in taking a number of matches at a time, the object being to take the last match.

The number of matches a player can take can be from one to any suitable number; it is usually three. The problem happens when the computer becomes one of the players, because although it would be easy to have the computer take random numbers of matches, a thoughtful move is not so easy. There is a rule for this game which should ensure a win. You might like to try and find it before next month.

If you do so you might like to try a

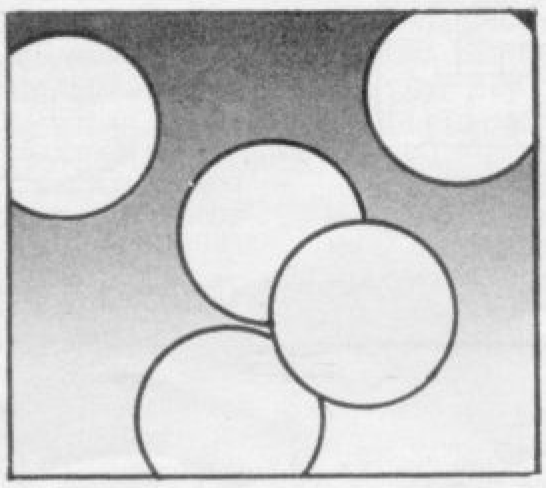


much more interesting program, that of three-pile Nim. You have three piles to choose from; on each move you can take any number of matches, from one to however many there are, from any one pile. The rule to ensure a win is now more complicated but I know of at least one and there could be others.

I now refer to a letter I received from David Egdoll of Glasgow. He has sent details of games played against versions of chess for the ZX-81 and other chess computers. He has bought the first **Artic Chess** program and his comment was: "I found it played fairly well at level three but unfortunately it took too long to make a move at that level".

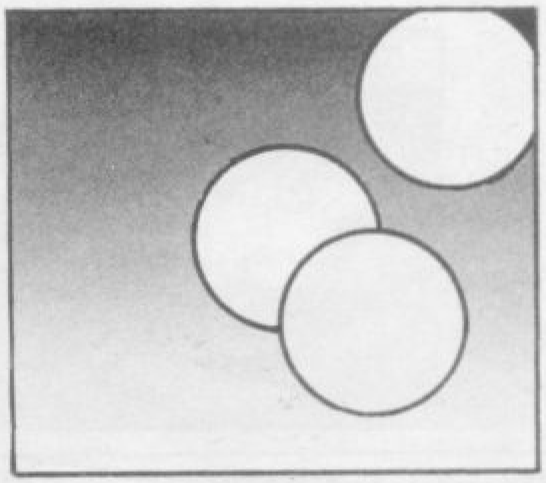
True to the computer industry, a **ZX Chess II** appeared from Artic. Edgoll also bought a **Micro-Gen version** of chess. He says that he was not impressed with its standard.

He has included details of games played against **Artic ZXchess II** and the **Voice Challenger,** a dedicated chess computer. I was amazed at the results and I think you will be. The ZX-81 playing at level two and the VC at level three, the 81 won



two out of two games. The 81 on level two against the VC on four, still won two games and had two draws. With the 81 on three and the VC on five to six, the 81 won four, had one draw and lost one. That mounts up to something stunning; out the 19 games played, the 81 had six wins, one loss, and three draws.

Those results are revealing, to say the least, I suppose it proves that the ZX-81 can, with the proper

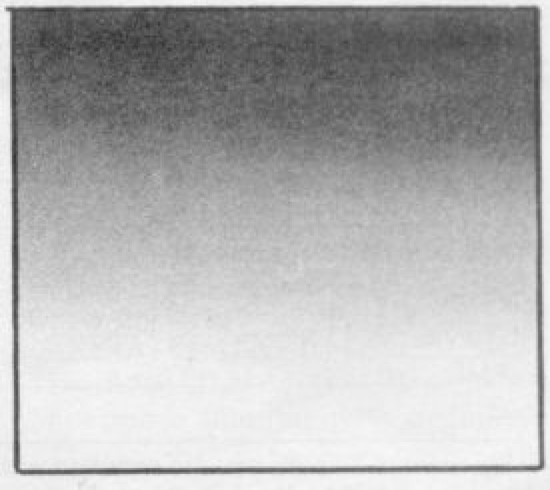


software, match and may exceed dedicated chess machines. Whether that would be so over a large number of games I am not sure but over the few it looks as if that might be true.

I should like to see a game of chess between a ZX-81 and a chess computer. If anyone would like to send one I will include it. Has anyone other comments on what has been revealed? I think that a great deal can be said about such results. Could it just be that the skill presented by the ZX-81 is superior to the Voice Challenger?

I should like you to direct all comments and your programs of Nim to 130 Rush Green Road, Romford, Essex, RM7 0QA. Please send any comments about any type of mind game you have played or designed on the 81.

Voice Challenger is made by Fidelity Electronics. ZXchess and ZXchess II are produced by Artic Computing of Hull.



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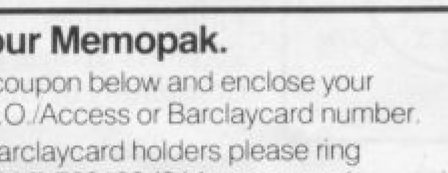
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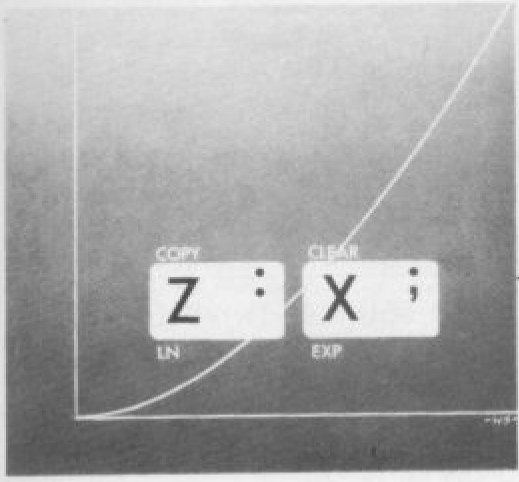
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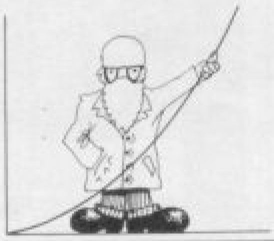
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Number crunching with common logs

Ian Stewart continues his exploration of the ZX-81 keyboard with a look at the capabilities of EXP and LN.

IN the last issue we looked at the meaning and uses of the trigonometric functions SIN, COS, and TAN. SIN and COS tend to be needed for anything which involves circles, which makes them especially important, even if you do not care a hoot for trigonometry.

This month it is the turn of EXP and LN. Unlike the trig. functions, you will usually need these only for number-crunching, performing calculations with mathematical formulae.

The Basic instruction EXP X corresponds to the mathematician's formula exp (x) or, more common, e^x. LN Y is the natural logarithm, ln(y) or $\log_e y$.

Exponentials and logarithms are very common in scientific work. They occur in statistics, radioactive decay, chemical reaction rates, absorption of light by inter-stellar dust, and you never know, you might need them one day.

To make life easy the Basic notation A**B will be used to mean "A raised to the power B". When B is a positive whole number, this has a simple meaning, for example A**1=A; A**2=A*A; A**3=A*A*A.

When B is not a whole number the Bth power is defined in such a way that the fundamental equation A**(B+C) =(A**B)*(A**C) holds. For instance, if X = 10**0.5 then X*X =10**(0.5 + 0.5)=10**1 = 10, so X must be the square root SQR (10).

The exponential function EXP calculates the powers of a certain number, which mathematicians call e, roughly equal to 2.7183. If you PRINT EXP(1) this number will be shown in a little more detail. In general, EXP B is the Bth power of e; that is, EXP(B)=e**B.

This weird number first became important in about 1594 in the work of John Napier on logarithms. The symbol ws introduced by Leonard Euler in 1728.

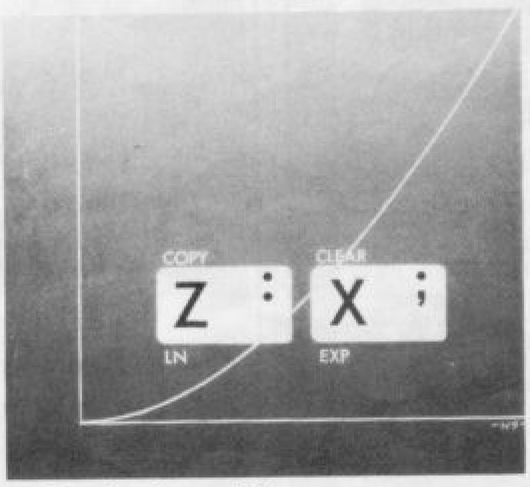
One way to see how it arises naturally is to consider compound interest.

If £1 is invested at an annual rate of interest of 100%, compounded yearly and if inflation gets much worse this is a likely scenario, then, every year, it doubles. In N years it will have grown to £2**N.

Suppose that the interest is worked out, not every year, but every 0.1 of a year; to keep things fair, the rate should then be 10 percent After 0.1 years the investment has risen to £1.1; after 0.2 10 percent is added, getting £1.21; then £1.331, £1.4641, and so on.

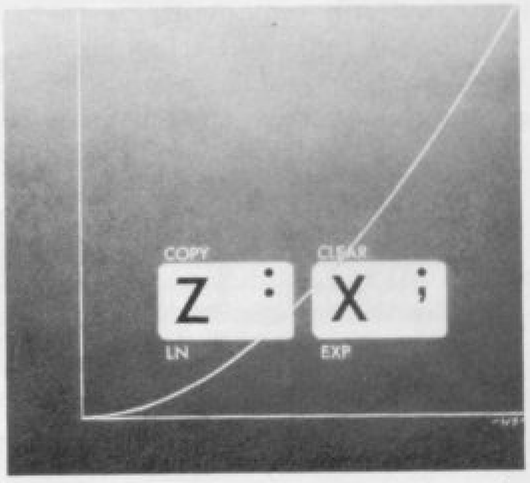
After one year this gives £(1.1)**10, about 2.594, and after N years it will be £(1.1)**(10*N).

Interest at one percent compounded every .01 of a year, after similar analysis gives £(1.01)**100, or 2.7048 after one year and after N years, £(1.01)**(100*N).



Continuing this process, compounding smaller and smaller interest at more and more frequent intervals, the total after one year gets closer and closer to 2.718. And after N years it will be roughly e**N=EXP N pounds.

The smaller the intervals still, the better the approximation, though the limitations of ZX-81 arithmetic make it more difficult to see this directly. If you attempt (1.000001)**1000000 you will get 2.7176683 which is a worse approximation, due to round-off errors in **.



There is a mathematical formula for e which explains this. It says that (1+1/N)**N gets very close to e as N gets large.

Test it:

```
1 FOR I=1 to 5
20 LET N=10**I
30 LET E=(1+1/N)**N
40 PRINT N,E
50 NEXT I.
```

The function LN is the inverse to EXP, that is, if EXP X=Y then Y=LN X. This program should convince you:

```
10 FOR X=1 to 20
20 PRINT X, EXP LN X
30 NEXT X.
```

For mathematicians, the most important properties of these two functions are probably that they satisfy the equations:

EXP (A+B)=(EXP A)*(EXP B)

LN (A*B)=(LN A)+(LN B).

For those familiar with ordinary

(continued on page 54)





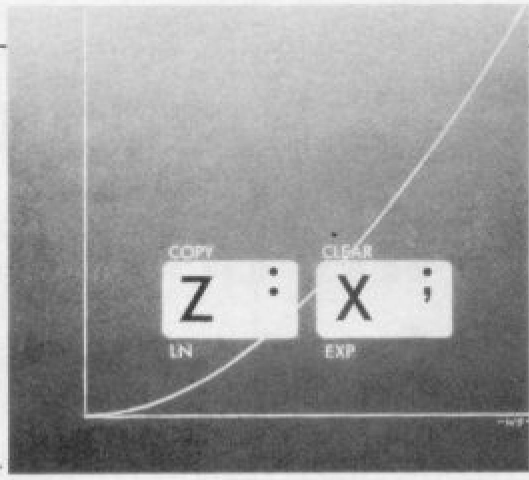
(continued from page 53)

logarithms, LN is the natural logarithm. The usual log is a multiple of this, namely log X = (LN X)/(LN 10).

Historically, the logarithm was used to turn multiplication sums into additions. The advent of computers has made this technique irrelevant but EXP and LN are still important for other reasons. For instance, EXP shows up in the shape of a hanging chain – a curve called the catenary.

```
10 FOR J=0 TO 60
20 PLOT J, (EXP(.1*(J–30))+EXP
   (.1*(30–J)))*1.5
30 NEXT J
```

As a final illustration, consider what population theorists, or demographers, call exponential growth. The idea is that the Earth's population increases each year just like compound interest, so that after N years an initial population P



becomes P*((1*R)**N) where R is the growth rate.

In 1220 Leonardo Fibonacci invented his famous sequence of numbers:

0 1 1 2 3 5 8 13 21 34 55 89 144 . . .

Each is the sum of the previous two and was a model of the explosion of a population of rabbits. The numbers grow almost exponentially.

This program generates the Kth Fibonacci number, F(K), and also works out (LN F(K))/K for reasons to be explained below:

```
10 LET B=1
20 LET N=0
30 LET K=0
40 LET C=B
50 LET B=B+N
60 LET N=C
70 LET K=K+1
80 PRINT B, (LN B)/K
90 IF K > 20 THEN SCROLL
100 GOTO 40.
```

The second column of numbers clearly settles down towards a value, R say, close to 0.4794403. So approximately, the Kth generation of rabbits has F(K) members, where (LN F(K))/K = R. Then LN F(K) = K*R, so F(K) =EXP (K*R) = (EXP R)**K.

The theoretical value for EXP(R) is the golden number (1+SQR 5)/2.

As a quick check, we ask PRINT LN((1+SQR 5)/2 and get 0.48121183, which is pretty close.

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Andrew Hewson



Making the best use of memory

THERE is a great deal of interest in the various ZX-81 RAM packs on the market and this month's column is devoted to questions about the efficient use of memory to enable you to decide which RAM would suit you best. I also answer some questions about the RAMs. Susan James of Aberdeen writes:

I have a 1K ZX-81 and I keep running out of memory. Is there an easy way to work out how much space is required by a program? Have you any tips about how to shorten programs without altering their function?

The answer to the first question is no. The amount of space used to hold the program can be found by entering:

PRINT PEEK 16396 + 256 * PEEK 16397 – 16509.

That line calculates the address of the end of the program area – held in D FILE at 16396 and 16397 – and subtracts the address of the beginning of the program area – i.e., 16509 – but more space is required when the program is running and to hold the display file.

In the ZX-81, the display file occupies 25 bytes plus one byte for each character on the screen – including leading blanks generated by PRINT AT, TAB and commas in PRINT statements. Space is also needed during execution to hold the variables area, the calculator stack and the machine and GOSUB stacks.

The amount of spare space at any time is the difference between the address held in the stack pointer (SP) and the address held in STKEND – at 16412. Unfortunately SP can be obtained only using a machine code routine.

In any case, the use of memory changes dynamically during execution and so the amount of spare space varies, too; hence my advice is that if you want to know how much space your program alone uses, then have a look at D FILE by entering PRINT PEEK 16396 + 256*PRINT PEEK 16397.

The bigger your program, the bigger the result. Alternatively, for an idea of how much space has been used after a program has RUN, have a look at STKEND by entering:

PRINT PEEK 16412 + 256*PRINT PEEK 16413

The difference between the result and RAMTOP – 17408 on the 1K ZX-81, 32768 with the 16K RAM – reflects the amount of spare space but allows about 100 bytes for the stack.

In this column Andrew Hewson, author of HINTS & TIPS for the ZX-80 and HINTS & TIPS for the ZX-81, answers your questions on hardware and software for Sinclair computers. Please address your problems, queries and comments to Andrew Hewson, HELP-LINE 7 Grahame Close, Blewbury, Oxon.

There are many tricks you can use to shorten a program without changing its function and to use them to full effect you need to understand the code used to store Basic



program lines. There are three rules:

Each line has an overhead of five bytes – two bytes to hold the line number, followed by two bytes to hold the length of the remainder of the line and a single byte containing decimal 118 at the end of the line.

Each character – letters, punctuation marks, graphics characters – occupies one byte each, as do keyboards like PRINT, LET, FOR.

Numbers are held both in character form and in numeric form. The character form uses one byte per digit and is followed by a byte containing 126 and then five bytes containing the numeric form. I explained the interpretation of the numeric form in detail last month.

For an idea of the way the rules work, plug-in your ZX-81 and enter:

```
10 FOR A = 16509 TO 16548
20 PRINT CHR PEEK A
30 NEXT A.
```

(continued on page 58)





(continued from page 57)

That program looks at the contents of the first 40 bytes of the program area, so it looks at itself.

My advice on shortening programs is:

Omit REM statements and keep PRINT statements as short as possible.



Use the code function to set variable values if possible; for example, use:
LET A = CODE "K"
rather than LET A = 48

Keep the number of variables to a minimum by re-using them for a new purpose. Loop counters in particular use a good deal of space in the variables area.

Use single letters only for variable names.

The next question concerns the variables area and is from Ken Griffiths, who asks:

What is the formula for the size of an array?

The answer to the question is on page 173 of the ZX-81 Basic Programming manual. The formula is:
4 + 2* number of dimensions + 5 * total number of elements.

An array B (2, 5, 6) has three dimensions and 2*5*6 = 60 elements. Hence it requires 4 + 2 * 3 + 5 * 60 = 310 bytes.

The equivalent formulae for the other variables are:
NUMBER: 5 + one byte per character of the number
LOOP CONTROL VARIABLE: 18 bytes
STRING: 3 + one byte per string item
CHARACTER ARRAY: 4 + 2* number of dimensions + number of elements.

I have received a number of questions about the RAMs, from, in particular, Jason Lowe of Rishton, Steve Harrop of Tamworth, Geoff Hewitt of Edinburgh, and Russell Walkinson of Huddersfield, who, incidentally, wrote the funniest letter this month.

Can any program written for a ZX-81 with or without 16K RAM be used with any of the RAMs? Yes, provided that you have sufficient RAM to accommodate the program it can be run using any of the RAMs but it is no use attempting to run a 16K program if you have, say, only a 4K RAM.

Are special programs required for RAMs larger than 16K? No; you can add up to 48K of RAM starting at address 16384 without requiring special software, although there are two problems. The first is that the ZX-81 expects 16K of RAM at most and if you have more you must re-set the RAMTOP pointer from the keyboard when you plug in the power supply. To do so, enter:
POKE 16389, 4*M + 64 –256*INT((4*M+64)/256)
followed by NEW
where M is the amount of extra RAM you have. For example, if you add 32K of RAM enter:
POKE 16389, 192
NEW




Andrew Hewson

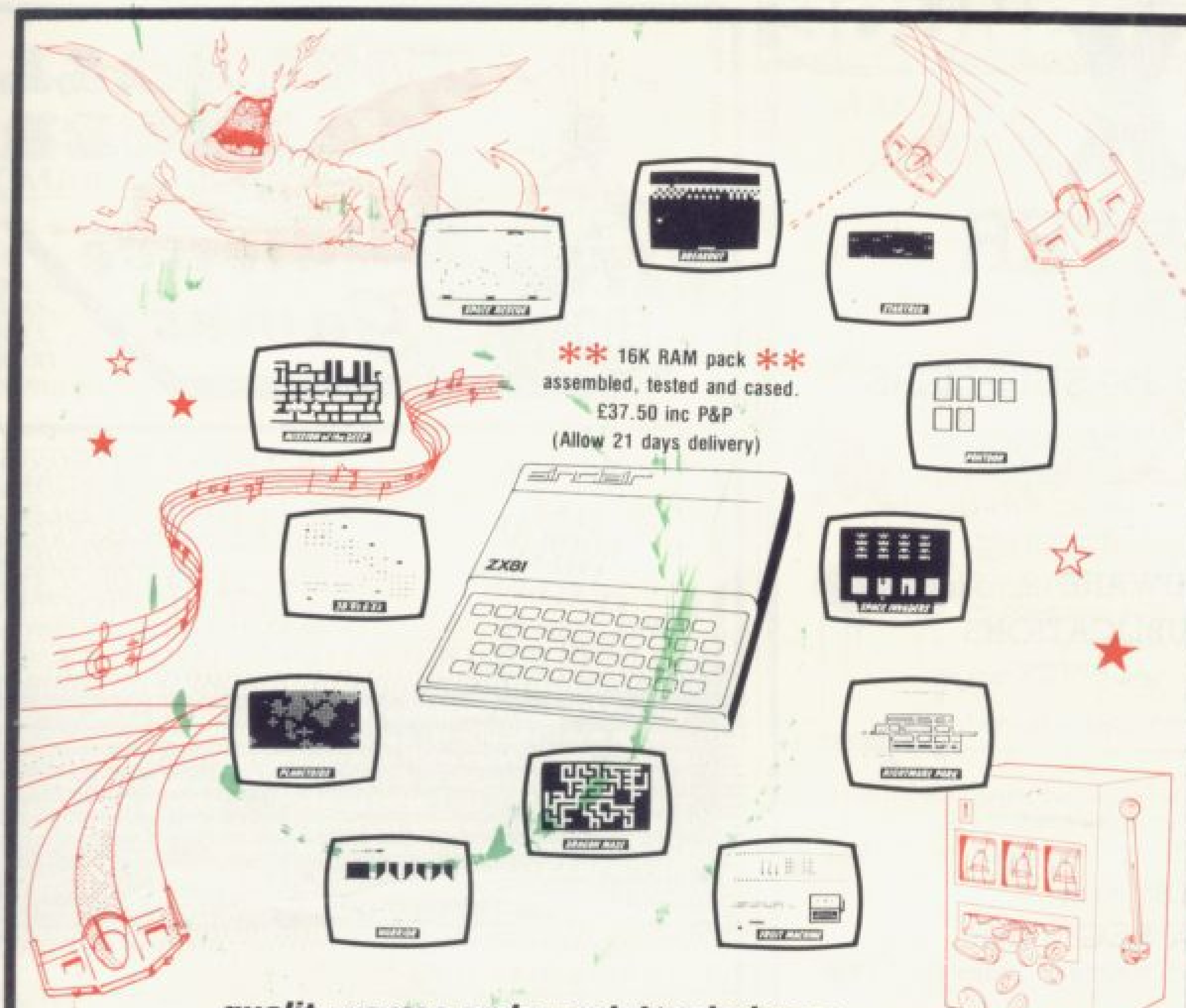
The second problem is that the display file must remain in the bottom 16K of RAM, as explained by Stephen Adam in *Sinclair User*, page 22, May 1982. Hence, unless you use special software, you are restricted to Basic programs smaller than about 15K. The remainder of the memory can be used to hold large arrays. The following line will give you an approximate idea of the size of your program:
PRINT PEEK 16397/4 – 16; "K".

What is the point of adding RAM between 8K and 16K?

The Sinclair ROM uses addresses 0 to 8191; 8192 to 16383 is normally unused and the 1K internal RAM and 16K and other add-on RAM normally use 16384 and upwards. Some of the memories now available provide RAM between 8192 and 16383.

The advantage of the facility is that the area is not accessible to Sinclair Basic except by using PEEK and POKE commands. So it can be used to store data without the risk of it being over-written. In particular, it is not over-written when a program is LOADed from cassette and it can be used to pass data between programs in a similar way to the routines I described for saving data above RAMTOP in the April, 1982 *Sinclair User*.

What does paging mean? The microprocessor on which the ZX-81 is based can look only at 64K of locations at any one time. Paging is a facility for separating RAM, usually but not necessarily into 64K blocks or "pages", so that processors can switch from one "page" to another.



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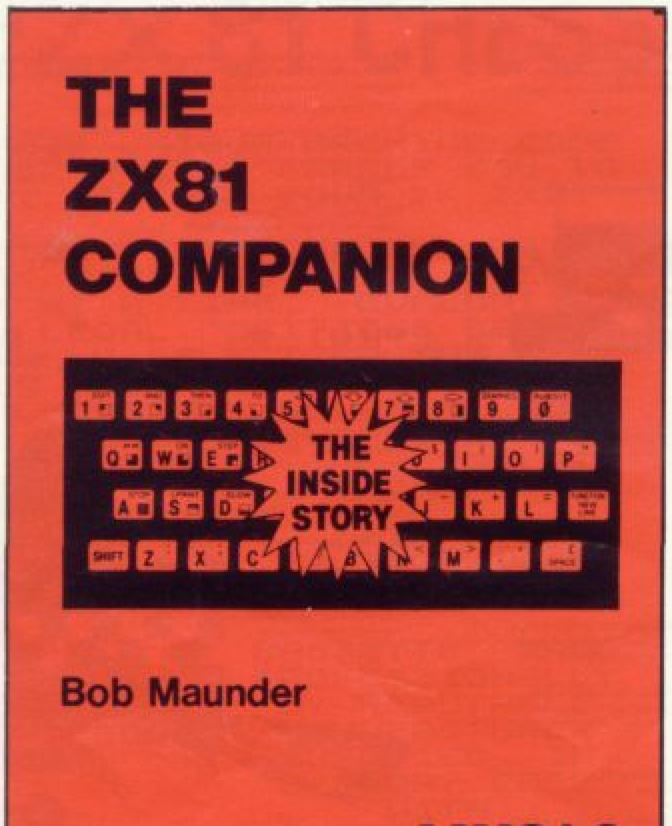
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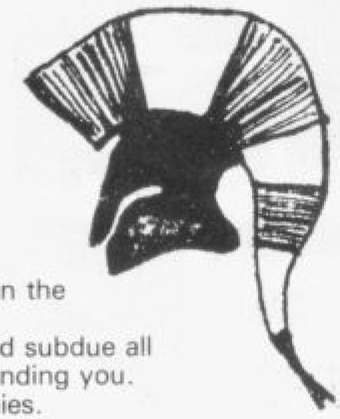
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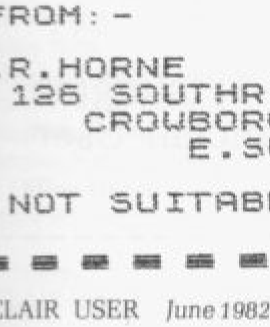
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Each month *Sinclair User* will be listing, free, the growing number of ZX user groups throughout the world.

We hope the list will be comprehensive and if anyone is forming a new group or knows of one we have not included, please let us know.

Britain

Aylesbury ZX Computer Club: Ken Knight, 22 Mount Street Aylesbury (5181 or 630867). Meetings: first Wednesday and third Thursday of the month.

CRL Home Computer Club: Mr and Mrs R. D. Hughes, Hillside, Steep Lane, Findon, Worthing, West Sussex, BN14 0UF (Findon 2750).

Edinburgh ZX Users' Club: J. Palmer (031 661 3183) or K. Mitchell (031 334 8483). Meetings: second Wednesday of the month at Claremont Hotel.

EZUG-Educational ZX-80/81 Users' Group: Eric Deeson, Highgate School, Birmingham B12 9DS.

Glasgow ZX-80/81 Users' Club: Ian Watt, 107 Greenwood Road, Clarkston, Glasgow G76 7LW (041 638 1241). Meetings: second and fourth monday of each month.

Hassocks ZX Micro User Club, Sussex: Paul King (Hassocks 4530).

Inverclyde ZX-81 Users' Club: Robert Watt, 9 St. John's Road, Gourock, Renfrewshire, PA19 1PL (Gourock 39967). Meetings: Every other week on Monday at Greenock Society of the Deaf, Kelly Street, Greenock.

National ZX-80 and ZX-81 Users' Club: 44-46 Earl's Court Road, London W8 6EJ.

North London Hobby Computer Club: ZX users' group meets at North London Polytechnic, Holloway Road, London N7 each Monday, 6pm.

Nottingham Micro-computer Club: ZX-80/81 users' group, G. E. Basford, 9 Holme Close, The Pastures, Woodborough, Nottingham.

Orpington Computer Club: Roger Pyatt, 23 Arundel Drive, Orpington, Kent, (Orpington 20281).

Post Office Users' Club: Vernon Quaintain, Head Post Office, St Martin's le Grand, London, EC1.

Scunthorpe ZX Club: C. P. Hazelton, 26 Rilestone Place, Bottesford, Scunthorpe; (0724 63466).

Worle Computer Club: S. W. Rabone 18 Castle Road, Worle, Weston-super-Mare BS22 9JW (Weston-super-Mare 513068). Meeting: Woodsprings Inn, Worle on alternate Mondays.

ZX Aid: Conrad Roe, 25 Cherry Tree Avenue, Walsall WS5 4LH (Walsall 25467) to cover Walsall and West Bromich area.

ZX Guaranteed: G. A. Bobker, 29 Chadderton Drive, Unsworth, Bury, Lancashire. Exchanges information and programs throughout country.

ZX-80/ZX 81 Users' Club: PO Box 159, Kingston-on-Thames. A postal club.

Overseas

Belgium, France, Luxembourg: Club ZX-80/81, Roger Betz, Chemin du Moulin 38, B-1328 Ohain, Belguim; (322 6537468).

Denmark: Danmarks National ZX-80/81 Klub (DNZK), Jens Larson, Skovmosevej 6.4200 Slagelese, post giro 1 46 24 66.

East Netherlands: Jonathon Meyer, Van Spaen Straat 22,6524 H. N. Nijmegen; (080 223411).

Germany: ZX-80 Club, a postal club; contact Thomas Jenczyk. Hameln, Postfach 65 D-3250 Hameln, Germany.

Indonesia: Jakarta ZX-80/81 Club, J.S. Wijaya, Jakarta, Indonesia.

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Spain: Club Nacional de Usuarios del ZX-81, Josep-Oriol Tomas, Avda. de Madrid, No 203 207, 10, 3a esc. A Barcelona-14 Espana.

United States: Bay Area ZX-80 User Group, 2660 Las Aromas, Oakland CA 94611. —Harvard Group, Bolton Road, Harvard MA 01451; (617 456 3967).



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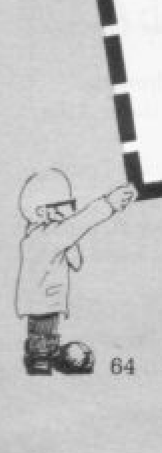
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